ILLUMINATING ENGINEERING

FEBRUARY 1953

Lamps and Lighting—A Vision of the Future
Characteristics of Baked Enamel Finishes
Pointers in Entering Lighting Contests
High Frequency Fluorescent Lighting
Pavement Brightness Measurements
Dormitory Lighting Design
Progress Report

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

THE PROBLEM:
how to get comfortable and effective lighting in a low ceiling room

THE SOLUTION:
a Wakefield Ceiling

When the Philadelphia Branch of the Howard P. Foley Company, electrical contracting company with branches coast to coast, needed more office space it modernized an existing garage to serve as the office of Vice President S. M. Cameron.

The problem of how to get comfortable and effective illumination in a low ceiling room was solved by installing a Wakefield luminous ceiling. Walls of striated plywood, painted light gray, and furniture with light green covering, add to the pleasant appearance of the office and simplify the visual tasks.

THE F.W.WAKEFIELD BRASS COMPANY · Vermilion, O.

Edwin H. Henrie of the Howard P. Foley Company and a lighting specialist from the local power company, collaborated in engineering the lighting specifications. Mr. Henrie reported the following results after the lighting system had been in operation for two months:

1. It proved very satisfactory to the occupant of the office.
2. It is in step with the trend to increase the ratio of area occupied by lighting equipment to the area of the office.
3. Direct and reflected glare was minimized.
4. It exceeds standards of the Illuminating Engineering Society for quantity and quality of light.
5. It offers a selection of three levels of illumination without disturbing the relatively even brightness pattern of ceiling. 18 fluorescent lamps (72 inch T-12) are mounted above the Plexiglas diffusers. Combinations of lamps of two circuits permit the selection of three different levels of illumination: 8 lamps give 50 footcandles; 10 lamps give 65 footcandles; all 18 lamps give 115 footcandles. The single-lamp channels, using a standard cool white fluorescent lamp, are mounted 18 inches on centers above the Plexiglas. The ceiling height is eight feet, ten inches.

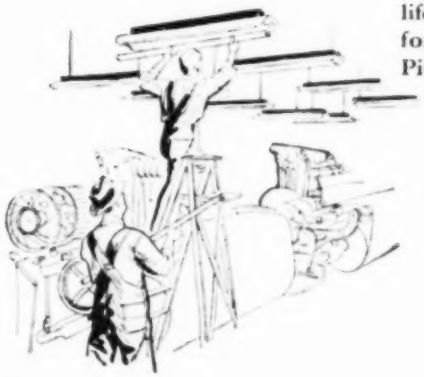
Wakefield **Over-ALL Lighting**

The Only Ballast of its kind

NEW LEAD-LAG SLIMLINE BALLAST

- **Small as a series ballast**
- **Economical as a series ballast**

Compare size, weight, price and power loss to a series ballast—then *add* longer lamp life, better maintenance, positive stroboscopic correction. That's the new Westinghouse LEAD-LAG ballast now available for all slimline lamps. No more lamp replacement guesswork . . . full-rated lamp life . . . more satisfied slimline customers. Get the whole story. Send for B-5614, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-04315



YOU CAN BE SURE... IF IT'S

Westinghouse

LIGHTING DIVISION

Edgewater Park, Cleveland, Ohio

EAST SIDE, WEST SIDE...
all around the town

NEW YORK CITY plays host to I.E.S.

Event: 1953 National Technical Conference of the Illuminating Engineering Society.

Dates: September 14 - 17.

Location: Commodore Hotel, New York, N. Y. . . . just four blocks from Times Square.

Program: A full presentation of the latest developments in the art and science of illumination . . . in the heart of the Entertainment Capital of the World.

Make I.E.S. Part of Your Vacation Plans

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

FEBRUARY
1953

Vol. XLVIII

No. 2

Dormitory Lighting Design for Visual Comfort and Efficiency — E. W. Commery and R. C. Putnam — 61

Pavement Brightness Measurements — D. M. Finch and R. B. Marsheimer — 65

I.E.S. Lighting Data Sheet — Series XVIII
Lighting an Elevated Roadway (26-25) — 75

Characteristics of 300-Degree White Baked Enamel Finishes — Fred E. Guth — 77

Lamps and Lighting — A Vision of the Future — J. N. Aldington — 82

The Kinorama as an Evaluator in Aviation Lighting — Discussion and rebuttal on paper by F. C. Breckenridge — 90

A Lumen Method of Daylighting Design — Discussion on paper by R. L. Biesele, W. J. Arner, E. W. Conover — 91

Pointers in Entering Lighting Competitions — J. O. Kraehenbuehl — 92

Characteristics and Applications of High-Frequency Fluorescent Lighting — J. H. Campbell, H. E. Schultz and D. D. Kershaw — 95

Questions and Answers on Light Sources — 104

Lighting Progress in 1951-1952 — 105

Also: Coffers in a Corridor, 81; Model Office Demonstrates Better Lighting, 94.

TELECAST — Lighting News of Current Interest — 6A

Lighting Calendar, 7A; Here and There with I.E.S. Members, 8A, 9A; About People, 16A; It Seems to Me, 19A; Obituaries, 19A; Books and Pamphlets, 20A; New Members, 20A.

I.E.S. National Technical Conference — 2A

Sustaining Members — 22A, 25A, 26A, 29A

Illuminating Engineering Society — 32A

I.E.S. Publications — 39A, 42A

Index to Advertisers — 41A

Committee Personnel, 1952-1953 — Refer to December 1952 issue of ILLUMINATING ENGINEERING.

I.E.S. National and Local Officers — Refer to October 1952 issue of ILLUMINATING ENGINEERING.

1952-1953 Officers

E. M. Strong — President

A. H. Manwaring — Vice-President

Duncan M. Jones — Vice-President

Clarence C. Keller — General Secretary

Kirk M. Reid — Treasurer

Staff

Ruby Redford — Editor

Clayton E. Ellis — Advertising Manager

Publications Committee

Duncan M. Jones, Chairman

J. S. Schuchert

R. M. Zabel

STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

Founded 1906

ILLUMINATING ENGINEERING SOCIETY

A. D. Hinckley
Executive Secretary

C. L. Crouch
Technical Director

PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

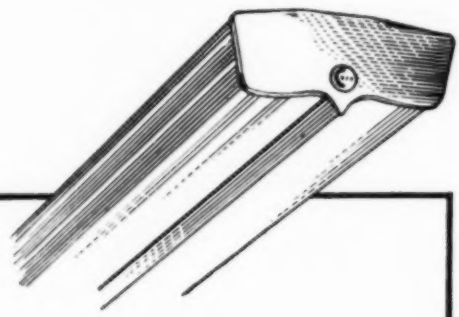
EDITORIAL and advertising offices 1860 Broadway, New York 23, N. Y.

ILLUMINATING ENGINEERING - The Journal of the Illuminating Engineering Society. Copyright 1953 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $10 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.

again and again

better seeing is achieved with EYE-COMFORT® *luminaires by* CURTIS

These photographs illustrate how Curtis engineering and design keep pace with progress. When incandescent lighting was indicated, the Curtis "Winner" was the choice. Years later, to assure continued "Eye Comfort"® illumination in completely modernized areas, the new Curtis "Princess" luminous indirect fluorescent unit was selected.



The new Curtis "Princess" luminous indirect luminaires have Curtis quality construction and workmanship throughout . . . with wire channel constructed of heavy gauge steel finished baked white "Fluracite" enamel. Side panels are fine ribbed durable polystyrene plastic to softly diffuse the light and provide low-brightness ratios between the ceiling and luminaire. Curtis "Princess" luminaires are available to accommodate all 4', 5' and 8' fluorescent lamps. Send coupon for complete descriptive information.

CURTIS LIGHTING, INC.

CURTIS LIGHTING, INC.
Dept. B41-19, 6135 West 65th Street
CHICAGO 38, ILLINOIS

Name _____ Title _____
Company _____
Address _____
City _____ State _____

Figure 1. The general visual environment is indicated by the brightness distribution within the students' field of view. The rough-textured light tan fabric shade lined with heavy white paper presents no unusual contrasts.

Dormitory Lighting Design For Visual Comfort and Efficiency

By E. W. COMMERY
R. C. PUTNAM

THE NUMBER of man-hours of engineering planning that was spent on the design of the student dormitory built at Case Institute of Technology last year, probably set a record for a building of its size and class. The college administration consulted with the various engineering specialists on the faculty to an unprecedented degree. In addition the student body took part in a realistic pre-testing of dormitory requirements.

Before starting the project, the entire student body was surveyed to determine (a) the need, (b) the size and (c) the possible rental return of the building. This information led to the decision to build the dormitory with 154 identical study-sleeping rooms for two men to a room. A full-size "mock-up" room was then constructed in one of the campus buildings and experimentally furnished and lighted. After many days of inspection by the student body, two "guinea pig" students moved into the room with their clothing, books and equipment and they lived there for several weeks. Suggestions from the hundreds of students who inspected the room and from the students who lived in it resulted in better design of space, furnishings and lighting, and incidentally, saved about $58,000 in the cost. The information obtained from this research and experimentation as well as co-operation from faculty members and alumni on various phases of design were then incorporated in the final plans as drawn by the architects.

From the first it was realized that the lighting of the dormitory was of primary importance and

AUTHORS: General Electric Company, Nela Park, and Case Institute of Technology, Cleveland, Ohio, respectively.

Figure 2. The arrangement of desks, lounge chair and lamps provides flexibility of use, utilization of space and a high order of visual comfort. The swing arms of both lamps make it possible to place either lamp back of the eyes of anyone seated in the lounge chair or to the right or left of either left- or right-handed students.

full co-operation was given to the authors by the architects and interior designers. The rooms were made attractive, with combinations of four basic co-ordinated color schemes which include walls, draperies, bed coverings, and light asphalt tile floors. These color schemes provided variety from room to room, although they were otherwise identical. The various reflectances were based on I.E.S. specifications and combine with the light distribution from the luminaires to give desired brightness patterns, resulting in visual comfort both for study and relaxation.

In an engineering college the students spend long hours in evening study which often involves plotting curves, making detailed mechanical drawings, and many other severe visual tasks which may cover a large area of the desk top. The tools with which they are working (slide rule, T-square,

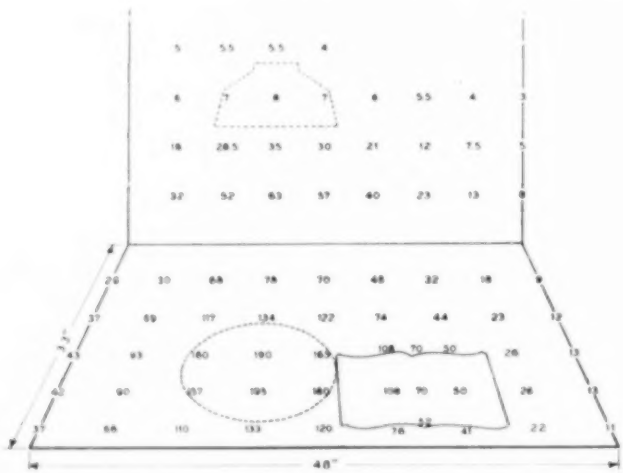


Figure 3. (left) The vertical shaft of the lamp extends 7 inches below the desk top and through a desk cross brace for rigidity. The normal position of the shade bottom is 14 inches above the desk top. By moving the two thrust rings which are locked into position with special screws the entire lamp can be moved up or down moderate amounts. Sturdy construction is provided through the use of a metal banded shade and a metal basket for the diffuser.

Figure 4. (right) The illumination values supplied by a typical sample of the study lamp measured in a 12-foot by 12-foot test room having ceiling walls and floors at 70, 50 and 15 per cent reflectance respectively. The location of the lamp is projected on the vertical and horizontal planes that represent a large desk top and part of the wall ahead of the student. A normal book position is also shown. The illumination positions are 6 inches apart; additional readings 3 inches apart are through book center.

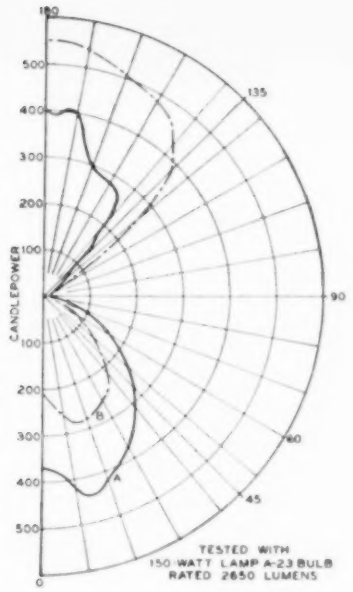


Figure 5. Comparisons of the light distribution curves of the new study lamp "A" and the earlier study lamp "B" made according to the former "I.E.S. Specifications." The great increase in both the spread and the proportion of downward light from "A" is easily noted. Average diffuser brightness of new study, 1,600 footlamberts. The ratio of downward to upward lumens in curve "A" is two to one. This ratio is reversed in curve "B." "B" is derived from an original curve using a 100-watt lamp.

triangles, standard curves, etc.) are often highly specular and may cause serious reflected glare. Experience has demonstrated that present-day college students have a tendency to place portable radios on their desks, in close proximity to the study lamps, so that radio interference is also a problem.

As the various requirements were considered, which included sustained periods of study associated with technical education, it was evident that a new design of study lamp was in order. An experimental study lamp that had been previously developed but had never been tested by students was placed on trial in the experimental "mock-up" room. Its reception was so wholehearted that a finished model was made to bring its fundamental design into key for use throughout the dormitory. Its appearance and lighting performance characteristics are set forth in accompanying charts and illustrations.

Its shallow, large diameter (10¾ inches) light-diffusing bowl provides a substantially greater area of light-source for the direct component of light than previous study lamp designs. They have usually used deep-bowl diffusers (8-inch dia.) placed rather high in the shade, with a 100-watt lamp. This new study lamp was designed for the A-23, 150-watt, 2650-lumen lamp.

The 4½-inch drop sides of the shade provide complete shielding of the bowl from the students' eyes. This shallowness of shade provides a greatly increased outward spread of light across the desk without creating a tall lamp. The shade not only shields the upward and downward light but it also plays an important part in controlling the ratio of downward to upward light. The upward light must be highly shielded by the shade since the eyes of those moving about the room will often be near the lamp. Normally the top of the lamp is only 51 inches above the floor. The student does not see the diffusing bowl or top of the lamp bulb in any reasonable position of study or living.

A moderate general level of indirect lighting (3 to 8 footcandles) is furnished by a central ceiling luminaire using a 150-watt silver-bowl lamp. This lighting fills in the low brightness areas in the visual fields and also provides a satisfactory level for moving about the room when used alone. The students are advised to use the central luminaire with the study lamp since its light increases the wall brightness directly back of the study lamp shade and between the two lamps by 25 per cent, thus improving these visually important areas. It also provides an improved visual field when the student is reading in the lounge chair since the opposite wall and floor are raised in brightness, which assures better overall visual comfort.

The lighting of the halls is somewhat unusual and very effective. The lamps are 96-inch, T-8

Figure 6. A continuous line of light from low brightness fluorescent slimline lamps makes for easy passage and simple attractiveness and also keeps all the corners clean along the floor.

Figure 7. (above) Two lamps each 8 feet long provide good shaving light for separate mirrors or a single long mirror. They also aid in supplying general light. The lower lamp is operated at low brightness as it is in the visual field. Light surroundings are a part of the design.

Figure 8. (below) The entrance lounge is given the feeling of home with well selected and well placed floor and table lamps.

fluorescent slimlines mounted in a continuous row down the center of the hall and operating at 100 milliamperes. Because of the resulting low brightness at this low current and the viewing positions that are predominantly lengthwise of the lamps the installation is comfortable and attractive without shielding; a distinct advantage for maintenance in a men's dormitory. The halls are five feet wide and eight feet high. The white acoustical ceiling, light tan brick walls and reddish-tan tile floor combine with the low brightness, continuous light source to give a soft effect with a high order of uniformity which averages 20 footcandles.

The toilet rooms and the mirrors are lighted by 96-inch, T-12 fluorescent slimline lamps, operating at two different current values (Fig. 7). The general room lighting comes from slimlines operating at 425 milliamperes and on the ceiling these are spaced 6 feet apart (one of these is shown in Fig. 7). The 96-inch, T-12 lamp shown directly above the mirrors operates at 200 milliamperes for low brightness as it is in the visual field when using the mirror. The months of use have justified the original design premise that these lamps are acceptable when located in these positions, operating at the specified current values and with the high reflectance of the white ceiling, very light tile walls and aggregate floor. The absence of shielding devices facilitates maintenance.

This installation gives very satisfactory lighting for shaving, the lighting levels at the shaving area averaging about 50 footcandles on the side of the face and approximately 18 footcandles under the chin, the latter coming mainly from light reflected upward from the light wall and the white wash-basins. The lighting level on the top of the head averages 125 footcandles. The plans originally called for one long mirror to extend over all the wash-basins and the lighting was planned accordingly. The toilet rooms are equipped also with special ozone lamps for odor elimination, one being mounted over each 200 milliampere slimline as shown in Fig. 7.

Tomlinson Hall, the student Union which adjoins the dormitory provides facilities for dining, lounging, library reading and recreation. Therefore, only an entrance lounge is required for the dormitory itself. Comfortable chairs and portable lamps of good design give this lounge a homelike atmosphere with a beautiful view across a wooded parkway (Fig. 8).

The lighting levels and brightnesses were measured after a year of service without any special maintenance. The strenuous use of the past year has confirmed the practicability and easy maintenance of the installations and the reactions from the students bear witness of the visual comfort and efficiency of the lighting throughout the dormitory.

For I.E.S. Report on Lighting Progress During 1952, see page 105 this issue.

Pavement Brightness Measurements

By D. M. FINCH
R. B. MARXHEIMER

INCIDENT to a general investigation of road-surface characteristics by the Institute of Transportation and Traffic Engineering, University of California, Berkeley, attention has been given to roadway illumination. This discussion concerns the approach to investigation of roadway brightness, the development of equipment for gathering useful data, the manner of presenting results, and the actual results obtained on a limited number of road-surface samples.

The design concepts that are used in lighting for night driving include the premise that the most favorable conditions for seeing at any given adaptation level of the eye occur if the pavement appears uniformly bright to the observer. It is one of the objectives of the lighting engineer to try to achieve this condition regardless of whether the illumination comes from fixed street lights or mobile headlights on the vehicles.

This discussion will be limited to the case of roadway lighting with headlights, but the general definitions and concepts are applicable to either. Since the above design condition relates to the appearance of the roadway from the driver's point of view, it is obvious that it is the *brightness of the roadway* (considered as a physical quantity expressible in candles per unit area) rather than the illumination that is of primary importance insofar as the above criterion is concerned. Also, in order to predetermine the brightness characteristics of any roadway, it is necessary to have specialized reflectance information about the roadway surface as well as data on the illumination. The reflectance information must be defined in terms of the direction of the source, the direction of viewing, and the type, orientation, and condition of the pavement.

The purpose of the authors has been to collect and present data on several types of road surfaces under dry, damp and wet conditions which will permit the pavement brightness pattern, due to automobile headlights, to be calculated. The data are restricted to the directions of incidence and viewing that exist for headlamps and drivers' eyes at normal levels above the roadway. The angles of incidence and viewing are, therefore, limited to vertical angles from 1/10° to 8° above the surface of the roadway and horizontal angles from 5° left to 5° right of the vehicle centerline.

Three methods are available for making pavement brightness measurements:[1]

1. *Visual method* — utilizes a comparison type of instrument, such as the Luckiesh-Taylor Brightness Meter or the recently developed roadway brightness instrument by de Boer.[6]
2. *Photographic method* — generally consists of photographing the scene and a series of control brightnesses simultaneously. A densitometric analysis of the negative is then made to determine the pavement brightness values.
3. *Direct photometric method* — uses a photoelectric device and possibly a suitable optical system to read brightness values directly.

The direct photometric method has been developed and used exclusively in collecting the data used in this report. The details of the electronic circuit are described in a previous paper.[5]

Determination of a Pavement Brightness Factor

The brightness of a pavement area, for a given incident luminous flux, varies with different angles of observation. Since reflectance usually means the ratio of the total reflected to the total incident luminous flux, it cannot be used for pavement brightness calculations. For a particular incident and viewing angle it is necessary to have a multiplying factor which relates the density of incident luminous flux (horizontal illumination) to the brightness (in candles/sq ft).

Then: Pavement Brightness = Brightness Factor × Horizontal Illumination.

Referring to Fig. 1, let us define:

$K_{\alpha,\beta}$ = Brightness factor for a certain value of α, β and for a given horizontal angle between source and receiver.

B = Brightness of the roadway area in candles/sq ft or lumens/sq ft × steradian.

F = Luminous output of the source in lumens.

E_R = Illumination upon receiver, in lumens/sq ft.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHORS: Associate Engineer, Institute of Transportation and Traffic Engineering, Univ. of California, Berkeley, Calif., and Kaiser Engineers, Div. of Henry J. Kaiser Company, Oakland Calif., respectively.

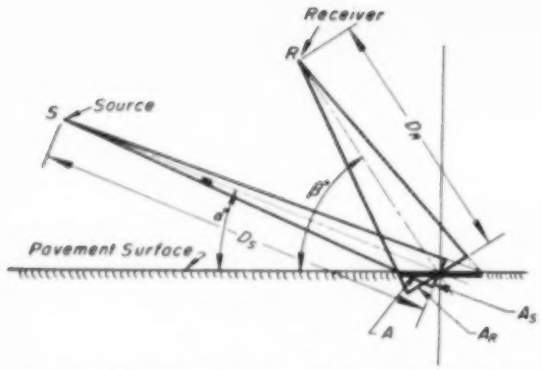


Figure 1. Schematic diagram of source and receiver positions.

α = Vertical angle from the horizontal to the source (beam centerline).

β = Vertical angle from the horizontal to the receiver (scanning centerline).

D_S = Distance from source to center of projected area of beam, in feet.

A_S = Cross sectional area of beam at distance D_S, in square feet.

D_R = Distance from receiver to center of projected area of beam, in feet.

A_R = Cross sectional area of cone scanned by receiver at distance D_R, in square feet.

A = Projected area of beam on the roadway, in square feet.

I_β = Intensity of pavement in direction of receiver.

We can express the brightness of the roadway in terms of the incident lumens in the source beam:

$$B \text{ is proportional to } \frac{F}{A}$$

So

$$B_{\alpha,\beta} = K_{\alpha,\beta} \times \frac{F}{A}$$

Also

$$B_{\alpha,\beta} = \frac{I_\beta}{\text{proj. area in direction of } R}$$

$$= \frac{E_R \times D^2_R}{A_R} = \frac{E_R \times D^2_R}{A \cos (90^\circ - \beta)}$$

So

$$K_{\alpha,\beta} = B_{\alpha,\beta} \times \frac{A}{F} = \frac{E_R}{F} \times \frac{D^2_R}{\sin \beta}$$

The brightness factor, $K_{\alpha,\beta}$, may be determined using the above expression by measuring E_R for any given set of conditions. This has been done experimentally using the equipment as shown in Fig. 2.

Once the $K_{\alpha,\beta}$ factors have been determined for α, β and the horizontal angle between source and receiver, we may then obtain the actual brightness $B_{\alpha,\beta}$ of the road if we know the horizontal illumination on the road, E_η.

$$\text{Brightness } B_{\alpha,\beta} = K_{\alpha,\beta} \times E_\eta$$

Experimental Equipment

The complete assembly of parts used to make the brightness factor measurements is shown in Fig. 2. This equipment was designed and developed at the Institute of Transportation and Traffic Engineering, University of California, Berkeley. The components consist of the following units:

1. *Light Source:* G-E Spotlight No. 4515 (30-watt) mounted in a lamp housing. A 1½-inch shielding tube, with a ¼-inch aperture at each end is used to limit the beam width. The pavement area thus illuminated is sufficiently small for complete scanning by the receiver.

2. *Receiver (Brightness Meter):* In this application an instrument is required that will give a full scale deflection on the galvanometer for values of illumination of 1×10^{-7} lumens/sq ft at the receiver phototube. A low level photometer, originally designed for use as a component of a reflex reflector photometer was used for the measurements.[5]

3. *The Mounting Arms:* Consist of a frame 12-ft long made up of aluminum angles to form a triangular truss. They are light weight to facilitate horizontal rotation but are rigid enough to support the receiver and the light source without appreciable distortion when the vertical angle is changed. The mounting arms have a bracket at each end: one is fastened to the swivel stand, the other is provided with two guides in which the vertical poles can slide.

4. *The Vertical Poles:* Consist of two tubes about 3½ ft long which permit the variation of the vertical angle. They are marked at approximately every 2.5 inches to indicate each 1° of vertical angle.

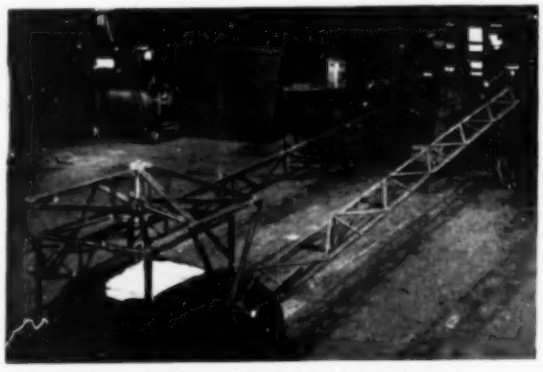


Figure 2. View of experimental equipment.

5. *Swivel Stand:* Consists of a frame approximately 2-ft square, around the axis of which the two mounting arms rotate. The swivel stand permits each arm to rotate through about 50° horizontal angle from the original 0 position, or a maximum of 100° between source and receiver.

6. *Light-Tight Tunnel:* A light-proof tunnel was constructed consisting of 14 wood panels which can be disassembled. It permits the whole equipment to be covered when in the field to prevent any outside light from penetrating into the area of measurement. It is planned to use the equipment for measurements on actual roadways without disturbing the surface.

7. Pavement samples will be described later.

Technique of Measurement

The source was calibrated for total lumens in the beam using an integrating hemisphere and standard reference lamps calibrated by the National Bureau of Standards.

The receiver (brightness meter) was calibrated with a reflectance standard illuminated by a calibrated source. The photometer has a linear variation of galvanometer deflection versus illumination.

For the headlighting situation we are particularly interested in low angles of incidence and reflection, and since in the experimental set-up, the physical dimensions of source and receiver limit measurements to approximately 1° vertical, a platform was constructed to raise the pavement sample and swivel stand. In this manner laboratory measurements can be made down to 1/10° above the plane of the pavement.

Additional precautions were taken to eliminate stray light by using dull black cloth to cover the edges and front face of base below pavement surface, to avoid any reflections from the base and edges. Before starting the measurements, precautions were taken so that the cloth did not prevent any part of the luminous flux from falling upon the pavement surface. The positions of receiver and source for which the vertical angle is 0°, were then noted. The vertical angles of the source and receiver were varied from about 0°-10′ above the pavement surface to 8°. The horizontal angles were the angles between the light source, or the receiver and the reference direction of the pavement. The relative positions of source and receiver are shown in Fig. 3. The horizontal angle of the receiver was varied for example, from 0° to 2½° right of pavement center without any noticeable change of illumination at the receiver. The horizontal angle of the source was varied from 0° to 2½° left of pavement center without noticeable change of illumination at the receiver. On the graphs, horizontal angles from − 2.5° to + 2.5° express this condition.

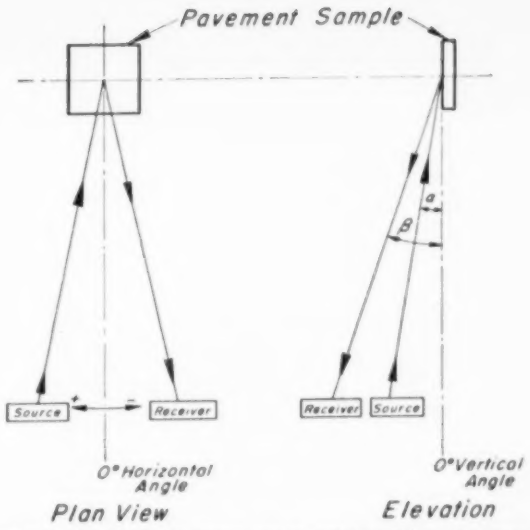


Figure 3. Reference figure for relative position of source and receiver.

Results and Applications of Measurements

Three different pavement surfaces were examined in dry, damp and wet conditions. For each condition, a graph was drawn showing for certain horizontal angle combinations, the variation of the brightness factor with the source and receiver vertical angles. Refer to Figs. 4 to 13.

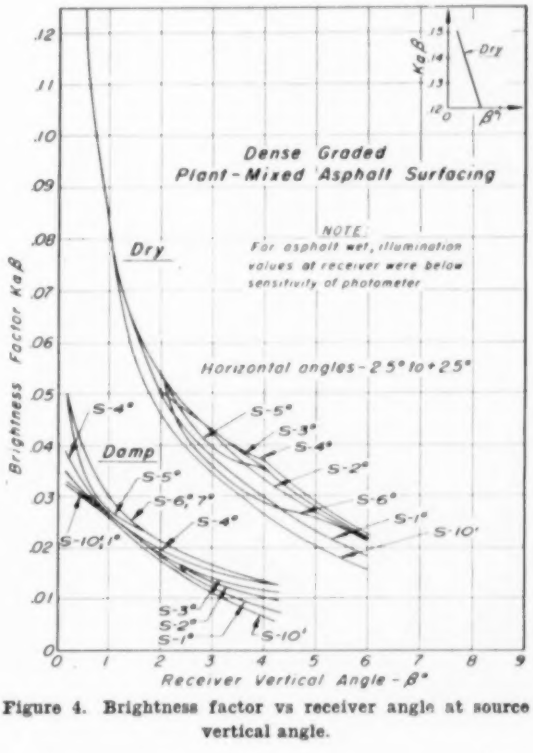


Figure 4. Brightness factor vs receiver angle at source vertical angle.

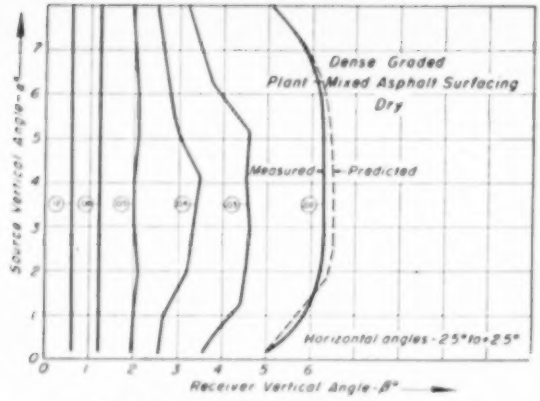


Figure 5. Iso-brightness-factor curves.

Brightness factor values for all vertical angles examined were entered with two significant figures, giving a graphical and numerical picture of the brightness factor variations. More detailed graphs may be obtained by interpolation between the iso-brightness-factor curves.

Three types of pavement surfaces were investigated as follows:

1. *Plant-Mixed Asphalt Surfacing:* A 15 x 19-inch sample of plant-mixed asphalt surfacing was taken from San Pablo Avenue in El Cerito, California. Built originally as an asphaltic concrete road in 1934, it was resurfaced in 1943 with dense graded plant-mixed surfacing using 5 per cent of 120-150-penetration paving asphalt. Daily average traffic on the four-lane road was 19,000 vehicles, including 7 per cent trucks. With the Baumgartner Reflectometer in the dry condition, a reflectance of 6 per cent was measured; in the damp condition, a reflectance of about 3 per cent was measured. Brightness factor data are given in Figs. 4, 5 and 6.

With horizontal angles ranging from $-2.5°$ to $-5°$ for receiver and from $+2.5°$ to $+5°$ for

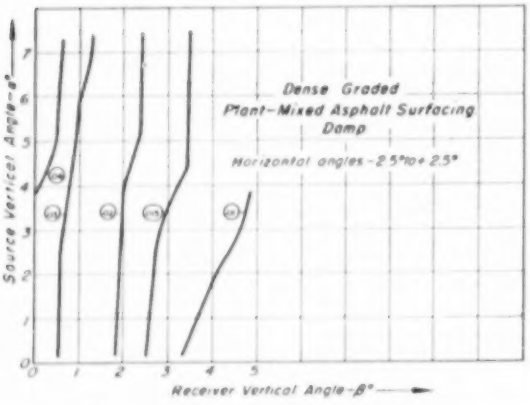


Figure 6. Iso-brightness-factor curves.

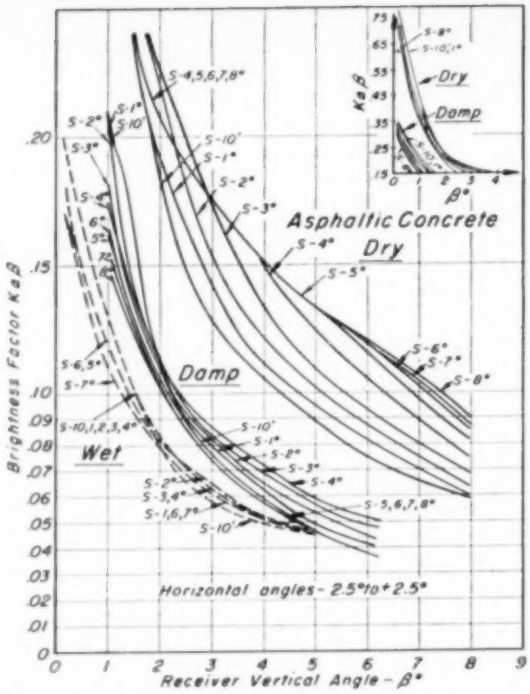


Figure 7. Brightness factor vs receiver angle at source vertical angle.

source, the following correction factors should be applied to the brightness factor values for all vertical angles measured:

Dry condition:	1.06
Damp condition:	1.03

2. *Asphaltic Concrete:* A sample about 15 x 20 inches was removed from Hoffman Blvd., Richmond, California. This is a four-lane, asphaltic concrete road which was resurfaced about 1948 with light plant-mix one inch thick, with one-half inch maximum size rock, dense graded with 5 per cent,

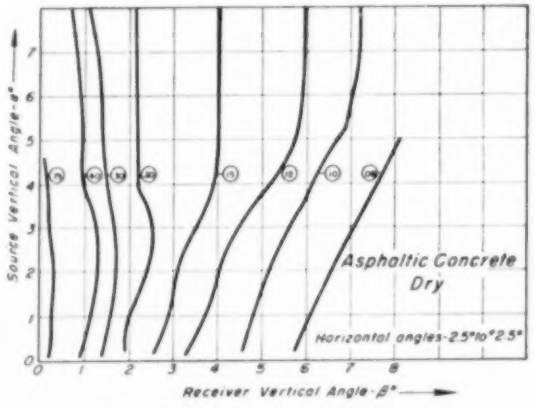


Figure 8. Iso-brightness-factor curves.

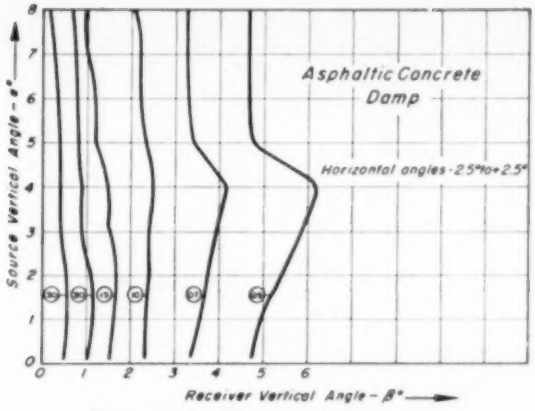


Figure 9. Iso-brightness-factor curves.

200-300-penetration asphalt. Daily average traffic was 25,000 vehicles, including 9 per cent trucks. The Baumgartner Reflectometer for the dry condition gave from 11 per cent to 14 per cent reflectance; for the pavement damp, about 8 per cent to 10 per cent; and for the pavement wet, about 5 per cent. Brightness factors are given in Figs. 7, 8, 9 and 10.

With horizontal angles ranging from $-2.5°$ to $-5°$ for receiver and from $+2.5°$ to $+5°$ for source, the following correction factors should be applied to the brightness factor values for all vertical angles measured:

Dry condition:	1.08
Damp condition:	1.04
Wet condition:	1.01

3. *P.C. Concrete:* A sample about 13 x 16 inches was removed from Highway 101, south of Ignacio, California; road constructed in 1917 (6 sacks of cement per cu yd). Daily average traffic on the four-lane highway was 22,000 vehicles, including 4 per cent trucks. The Baumgartner Reflectometer for the dry condition gave 24 per cent to 27 per cent reflectance; and for the wet condition, about 12 per cent reflectance. Brightness factors are given in Figs. 11, 12 and 13.

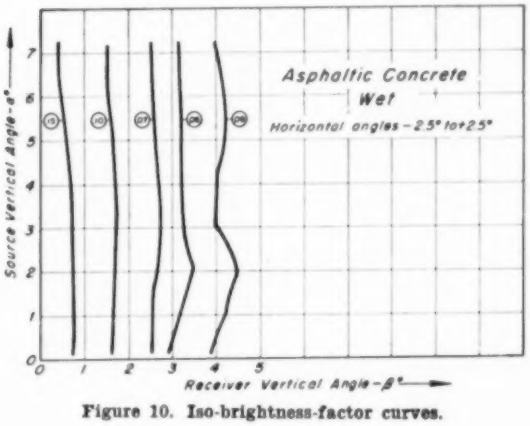


Figure 10. Iso-brightness-factor curves.

With horizontal angles ranging for receiver from $-2.5°$ to $-5°$ in dry and wet conditions and for the source from $+2.5°$ to $+5°$ in dry and wet conditions, the following correction factors should be applied to the brightness factor values for all vertical angles measured:

Dry condition:	1.14
Wet condition:	1.05

For all the pavement samples, it may be noticed that changes in the vertical angle of the receiver cause the most variation upon the brightness factor. The iso-brightness-factor pattern in the dry condition differs for the various surfaces. The $K_{\alpha,\beta}$ values for the P.C. concrete are relatively high when compared to the plant-mixed surfacing (ratio about 5:1), but there is much less difference when the concrete is compared to the asphaltic concrete (ratio about 2:1).

The iso-brightness-factor pattern of the asphaltic concrete sample, to a great extent, is due to the stone elevations above the surface which can be felt slightly by hand. The orientation and light color of these particles cause this sample to have relatively high $K_{\alpha,\beta}$ values even in the damp condition. In this state it may be noted that the asphaltic

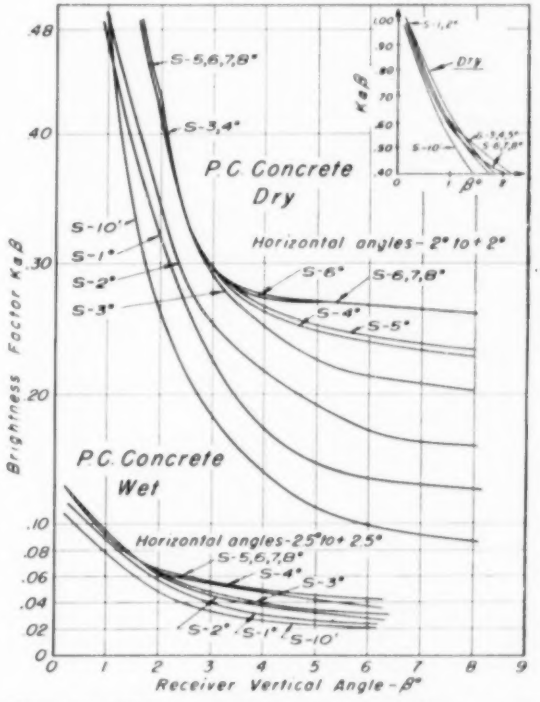


Figure 11. Brightness factor vs receiver angle at source vertical angle.

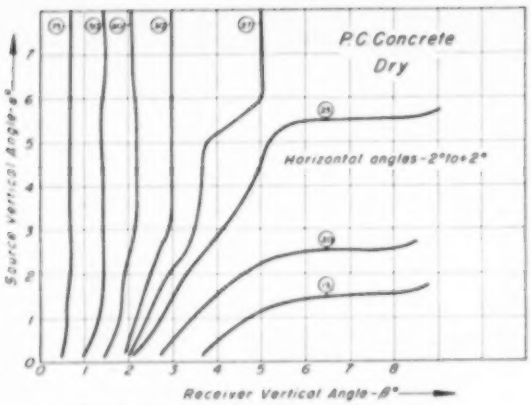


Figure 12. Iso-brightness-factor curves.

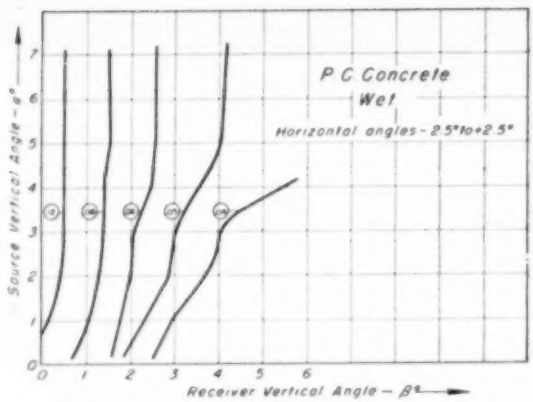


Figure 13. Iso-brightness-factor curves.

concrete damp has appreciably higher $K_{\alpha,\beta}$ values than the concrete wet. Even when wet, the asphaltic concrete has higher $K_{\alpha,\beta}$ values than the concrete wet. This interesting fact should be further investigated for similar pavements, but it can be concluded on the basis of these tests that coarse pavements with light-color stone aggregates present relatively high brightness factors, which is an advantage for night driving.

Example of Brightness Calculations On Various Pavement Surfaces

Let us assume that the motorist's eyes are 51 inches above the roadway and the headlamps are 30 inches above the ground level. Then at a distance of 143 ft on a level pavement, the receiver and source vertical angles will be respectively:

$$\beta = 1.65°$$
$$\alpha = 1.0°$$

With a standard sealed-beam unit, the luminous intensity in the direction of $1°D$, H would be approximately 27,400 apparent candlepower corresponding to a horizontal illumination of

$$\frac{27{,}400}{(143)^2} \times .0175 = .0234 \text{ lumens/square feet}$$

Contribution from the second sealed-beam (assumed 5 ft laterally from the first):

$$\frac{22{,}000}{(143)^2} \times .0175 = .0188 \text{ lumens/square feet}$$

The horizontal illumination will be

$$E = .0234 + .0188 = .0422 \text{ lumens/square feet}$$

Brightness factors and roadway brightnesses due to automobile headlamps are shown in Table I.

Once the iso-brightness-factor curves are determined for each combination of receiver vertical angle, source vertical angle and horizontal angle between the source and receiver, the actual brightness of the surface may be found for all points where the horizontal illumination is known. Through this method then the brightness pattern of the road surface can be obtained.

Conclusion

The data show large variations in brightness factors with changes in vertical angles and minor variations with changes in horizontal angles of source and receiver, the receiver vertical angle being the most important factor in causing variations.

For the angular ranges studied the P.C. concrete sample in the dry condition shows by far the highest brightness factors, as expected. The damp asphaltic concrete sample exceeds considerably in brightness factor values the damp plant-mixed surfacing sample.

In the wet condition the asphaltic concrete pre-

TABLE I.

Pavement	Dry		Damp		Wet	
	Factor	Brightness candles/ft²*	Factor	Brightness candles/ft²*	Factor	Brightness candles/ft²*
Plant-Mixed Surfacing	6.3×10^{-3}	2.6×10^{-3}	2.1×10^{-3}	0.88×10^{-3}	———	———
Asphaltic Concrete	28×10^{-3}	12×10^{-3}	15×10^{-3}	6.3×10^{-3}	10×10^{-3}	4.2×10^{-3}
P.C. Concrete	44×10^{-3}	18×10^{-3}	———	———	6.3×10^{-3}	2.6×10^{-3}

*Lumens/ft² x steradians.

sents higher brightness factors than does the wet P.C. concrete sample.

These preliminary results appear to warrant further study on actual highway surfaces in place, and such field studies are being planned.

Acknowledgments

Grateful acknowledgment is extended to Mr. R. A. Tremper, Assistant Maintenance Engineer, Division of Highways, San Francisco, for his help in obtaining various pavement samples.

Special thanks are due to the staff members of the Institute of Transportation and Traffic Engineering, University of California, Berkeley, for their valuable assistance in the preparation of this paper.

References

1. Wyatt, F. D.: "Pavement Texture and Brightness, Part I," ILLUMINATING ENGINEERING, Vol. XLIII, No. 10, pp. 1221-1232 (December 1948).
2. Paxson, G. S., and Everson, G. D.: *Light-reflecting Characteristics of Pavement Surfaces*, Oregon State Highway Department Technical Bulletin No. 12, 76 p. (December 1939).
3. Krachenbuehl, J. O.: "How To Measure Pavement Surface Reflectance," ILLUMINATING ENGINEERING, Vol. XLVII, No. 5, pp. 278-287 (May 1952).
4. Bergmans, J.: "The Brightness of Road Surfaces under Artificial Illumination," *Philips Technical Review*, Vol. 3, No. 11, pp. 313-321 (November 1938).
5. Finch, D. M.: "Reflex Reflector Performance Criteria," in *Reflectors and Night Visibility*, Bulletin No. 34, Highway Research Board, Washington D. C., pp. 21-40 (1951).
6. de Boer, J. B., Onate, V., and Oostrijck, A.: "Practical Methods for Measuring and Calculating the Luminance of Road Surfaces," *Philips Research Report*, Vol. 7, No. 1 (February 1952).

DISCUSSION

MERLE E. KECK*: My discussion of this paper is divided into two parts, the first part concerned with test procedure and method and the second part concerned with the application of the results. As regards the first part I wish to ask two questions, not in criticism of the techniques, but to gain information.

1. Was the sample of pavement rotated in a horizontal plane and an average of several measurements taken for each angular setting of source and receiver so as to eliminate any possibility of directional "grain" in the sample?
2. Was the area illuminated by the source and area scanned by the receiver kept equal to each other as the angles α and β of source and receiver were changed. If so, how was this physically accomplished?

In regards to the second phase of my discussion relative to the application of the results let me say first that I feel that there is a definite need for more information and more experimental data on the reflection characteristics of pavements and for that reason this paper is valuable. Let me also say that there is pressing need for a standardized method of expressing such reflection characteristics. Lastly, we application engineers must learn how to utilize the data and weigh its value in the overall street lighting picture.

It seems important to re-emphasize the point made by the author in the opening of the paper, that uniform pavement brightness is only one of the factors included in the concepts of lighting for night driving. There are many differences of opinion regarding the importance of uniform pavement brightness and it is my opinion that it is over-emphasized in a great many cases. It appears to me that the most important purpose of pavement brightness is to reveal to the driver the future direction and elevation of the roadway he will soon be traversing. This revealment, can in my opinion, be made easier by the use of white or reflecting center and edge lines which will give small areas of really appreciable brightness than by increasing the brightness of the entire pavement a few hundredths of a footlambert by treating the pavement surface in a particular manner.

I do not share the view of some people that the major method of identifying the presence of objects at night is by silhouetting them against a light colored pavement. In support of my view I ask you this question: If you were asked to walk down a well traveled highway at night for a considerable distance, would you choose to wear light or dark clothes? Obviously the choice of light colored clothes means you expect to be seen by direct illumination and reduces, nay literally removes, the possibility of your being seen as a dark object against the pavement brightness.

Let me repeat that the author does not state that pavement brightness is the only or even the chief factor in visibility on highways at night; however, I merely wanted to make this point lest the casual reader of the paper would tend to assume that point of view due to the fact that the paper, of necessity covers only that one factor.

L. J. SCHRENK*: The paper shows considerable work and care in its preparation and the author should be commended for his research work in this field. I believe he has made a very worthy contribution.

Pavement surfaces should be given more attention in road building as it is an important factor to be considered in the economics of lighting to provide adequate safety for traffic at night.

The author states that the general definition and concepts are applicable to either headlighting or fixed lighting; however, the application of these results to fixed lighting, I believe, is somewhat more complicated. Street lighting or fixed lighting gives a source of light ahead as well as behind the receiver, and the sources which are ahead of the viewer are the most effective in creating pavement brightness.

According to the data in Table I, the pavement brightness at 143 feet is in the ratio of about 7 to 1 between dry and wet concrete for headlighting. From observation it does not seem that this large ratio exists for fixed lighting especially if the light source is of the elongated type such as fluorescent lamps. Theoretically if the pavement is of a uniform texture on the surface, and the surface is smooth or uniform, then the plotted results should be a family of curves which do not cross each other. Since the curves do cross to some extent I cannot help but believe that there are other factors such as roughness of pavement, non-uniformity of texture, etc., which have entered into the results.

Also to be considered in street lighting as wet pavement is the highly specular qualities of the pavement, resulting in high values of pavement brightness which are negligible under headlighting.

*Westinghouse Electric Corp., Cleveland, Ohio.

*Public Lighting Commission, City of Detroit.

CHARLES MARSH*: This paper presents some much needed information in readily usable form. The application of these data to headlight beam patterns translates beam candlepower into more meaningful pavement brightness values. Conversely, a desirable brightness pattern can be now used as the basis for beam design.

It might have been easier to apply the data had the authors assigned to the Brightness Factor the dimensions $\frac{\text{Pavement Brightness}}{\text{Incident Candlepower}}$ rather than $\frac{\text{Pavement Brightness}}{\text{Horizontal Candlepower.}}$

I would like to see this careful work extended to other angles. It would be interesting to learn the qualities of paving materials at angles involved in silhouette seeing through the aid of oncoming lights. Pavements could also be compared on the basis of reflected glare, such as is found when driving into a low sun or when meeting cars, especially under wet conditions.

D. A. TOENJES and K. M. REID**: The most significant item in the ingenious Finch Marxheimer test facilities may well prove to be the illumination (or brightness) recorder. Let us not pass lightly over the statement that it provides a full scale deflection for illumination of one ten millionth of a footcandle. This high degree of sensitivity surely could be useful in other photometric applications. Very possibly this instrument has escaped the attention of most of the I.E.S. membership, since its only previously published description was in the Bulletin of the Highway Research Board. Is not this instrument of sufficient importance in our own field to warrant further description — perhaps as an article in ILLUMINATING ENGINEERING?

One question that occurred to us, and perhaps has to others, is in what ways this study of pavement reflectance by Finch and Marxheimer differs from the study of pavement reflectance by Professor Krachenbuehl at the University of Illinois.† They seem to compare as follows:

1. The angles here are applicable to headlighting only, while the Krachenbuehl study is devoted primarily to angles applicable to street lighting.
2. Results in both studies are expressed in terms of brightness ratios. At first glance they appear to be different, but actually they each use a ratio of brightness to illumination. Finch and Marxheimer express their ratios as $\left(\frac{\text{candles/sq. ft.}}{\text{lumens/sq. ft.}}\right)$ as compared to Krachenbuehl's: $\left(\frac{\text{footlamberts}}{\text{footcandles}}\right)$. Physically these ratios are alike, so that results from the two studies may be compared directly after a simple multiplying factor is applied to the numerical results.
3. This method has been designed for the possibility of actual measurements on the road surface, without removing a pavement sample. The Krachenbuehl facilities are for laboratory use only, employing pavement samples.

C. A. B. HALVORSON***: The authors appear to have developed an extremely useful instrument and method for investigating the characteristics of pavements insofar as their influence on visibility at night is concerned. Such an instrument should be available in the various Departments of Public Works at all levels of government to the end that better reflecting materials may be found and improved techniques developed to enhance pavement brightness at night. Let us hope that the authors will meet with a friendly response to their efforts from the hundreds of technicians working in the field of road building for safety, and the improvement of vehicular transportation generally.

However, the paper under discussion emphasizes how very inadequate the more common types of pavement surfaces are in producing areas of reasonably uniform high brightness under all kinds of weather conditions with the illumination from standard automobile lighting equipment. See their Table I. In this connection it occurred to me that it might be of interest to report at this time, an elaborate experiment tried out on the Taconic Parkway, near Poughkeepsie, N. Y. in the late thirties, to determine to what extent the brightness of pavements might be enhanced at night by properly coordinating the design of the pavement surfaces with the beams of low mounted units of the projector type pointed generally in the direction of travel.

Based on the theory depicted in Fig. A, 1000 feet of standard P. C. concrete pavement plus special curbs and medial strip was constructed by the contractor as a part of the regular year's commitment of extensions to the parkway highway system. With a specially designed brushing tool a fair simulation was effected of the pavement surface shown in the lower half of Fig. A. In addition the low curbs of white Atlas cement were modeled with a series of flutes in both the horizontal and inside vertical surfaces. Also a 6-inch medial strip of the same cement was incorporated between the two travel lanes. The cross brushing commonly specified by the Taconic Commission is shown at the left of Fig. B, and in the foreground of Fig. C. Note the line of demarkation in both cases.

Fig. C shows the effectiveness of the illumination of the specially designed surfaces. The measurements were made by the "Visual Method" employing the Luckiesh-Taylor Brightness Meter. The values in footlamberts are as indicated. The luminaires were of a slightly modified standard street lighting reflector-refractor type mounted about 30 feet above the pavement and spaced approximately 100 feet apart on one side of the highway. The beam candlepower was of the order of 2000.

Fig. D shows a night view of a well lighted thoroughfare employing similar luminaires of the reflector-refractor type using 6000-lumen lamps. The pavement is of sheet asphalt having a reflectance when dry of about 5 per cent. The brightness measurements were made by both the Visual and Photometric methods.

A similar installation was made on a roadway in Lynn, Mass., resurfaced with Chelmsford granite chips having a reflectance value, dry of 29 per cent and wet, 15 per cent. The applied illumination values in footcandles are shown in brackets in Fig. E. The remaining values are of brightness in footlamberts. Fig. E is from the paper entitled "Surfacing Asphalt Pavements for High Night Visibility," a part of the Transactions of the Association of Asphalt Paving Technologists, Vol. 10, January 1939.

Obviously in any discussion of pavement brightness, the question of durability of such superficial surfaces is raised. After the Washington, D. C. I.E.S. conference, I examined the experimental section of pavement at Poughkeepsie, N. Y.

---

*Pennsylvania State College, State College, Pa.
**General Electric Co., Nela Park, Cleveland, Ohio.
†"Measurement of Pavement Surface Characteristics," by John O. Krachenbuehl, ILLUMINATING ENGINEERING, May 1952, p. 278.
***Lighting Consultant, Lynn, Mass.

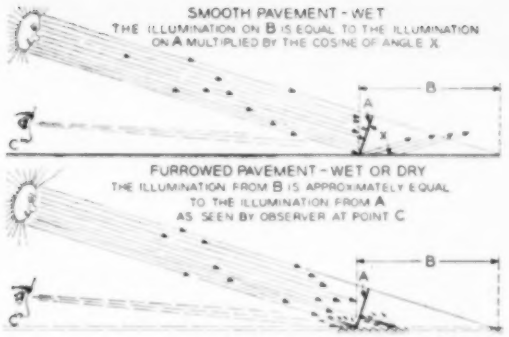

SMOOTH PAVEMENT - WET
THE ILLUMINATION ON B IS EQUAL TO THE ILLUMINATION ON A MULTIPLIED BY THE COSINE OF ANGLE X
B
A
X
C
FURROWED PAVEMENT - WET OR DRY
THE ILLUMINATION FROM B IS APPROXIMATELY EQUAL TO THE ILLUMINATION FROM A AS SEEN BY OBSERVER AT POINT C
B
A
C

Figure A.

Figure B.

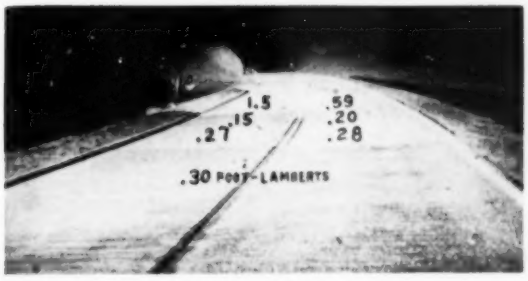


Figure C.

Figure D.

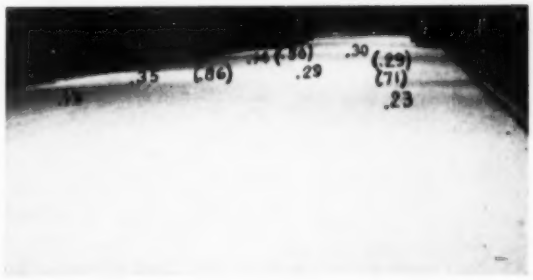


Figure E.

and found it to be in excellent condition; also, the use of the pavement and white fluted curbs had been greatly extended.

The resurfacing experiment in Lynn, Fig. E, carried out by a joint committee of the I.E.S. Street Lighting Committee and the Asphalt Institute still shows a remarkable gain in brightness over the adjacent bituminous asphalt pavement, after 13 years of wear.

It should be noted that in all three cases, the footlambert values are quite comparable, when averaged, and from this it would appear that the Street Lighting Committee now could start collecting similar data to the end that a new chapter may be added to our "Lighting Practice." These successful experiments show that the authors should be encouraged to continue in their studies of pavement characteristics and measurements.

R. M. SWETLAND*: We are indebted to Messrs. Finch and Marxheimer for this additional laboratory technique and data on accurately measuring pavement brightness; and for this added emphasis on the *importance* of such pavement brightness in the overall problem of most comfortable night roadway visibility.

Although this particular brightness investigation was based on automobile headlights as the primary source, it is reassuring to note the authors' statement that "the general definitions and concepts are applicable to either" — meaning, a *fixed* street lighting system.

Street lighting engineers, generally, will warmly applaud — and hope for the early implementation of — the final statement in the "conclusion" of this paper which reads, "These preliminary results appear to warrant further study on *actual highway surfaces* in place, and such field studies are being planned."

Evidence seems to indicate quite clearly that, to date, considerably more attention has been given to improving *lamp* efficiency and luminaire design, than toward investigating pavement surface reflectance and brightness and their influence on the ultimate objective of "maximum protective visibility per dollar of cost."

Consequently, it is hoped that these various laboratory and field studies may materially assist in achieving the following constructive and desirable objectives:

A. A more appreciative understanding, in general, of the importance of adequate pavement brightness in "visibility by silhouette."

B. The development of a more reliable and convenient instrument for accurately measuring pavement brightness, under actual installation conditions.

C. Supplementing — or possibly eventually supplanting — the present "average horizontal footcandle" basis of

*General Electric Lighting and Rectifier Dept., Lynn, Mass.

street lighting evaluation (Table IV, American Standard Practice for Street and Highway Lighting) with a table of substantiated footlamberts, or perhaps candles per unit area, for various traffic densities and classes of streets.

That is, design and install roadway lighting equipment to produce a pre-determined degree of *pavement brightness uniformity* — rather than an average horizontal *footcandle* level.

D. *Finally*, the developing of a recognized "*unit of visibility*," plus an instrument which will *reliably measure* such overall *street lighting visibility!*

It is constantly annoying — and frustrating — to strive toward the goal of "improved street visibility," while handicapped by the inability to conclusively *measure* and *evaluate* such progress — or even to label it by a recognized "unit."

It would appear that the "ultimate" in roadway lighting technique and achievement is, still, a considerable distance ahead. Therein lies the challenge to all of us.

D. M. Finch and R. B. Marxheimer*: Through pavement brightness the vehicle driver detects the direction and elevation of the roadway on which he soon will be traveling, he also needs to perceive and recognize all objects on the roadway, which are in most cases darker than the background. The greater the contrast between obstacles and pavement, the easier the obstacle is perceived. We agree with Mr. Keck that uniform pavement brightness is not the only factor influencing our visibility on highways at night; however, many investigators recognize that uniformity of brightness greatly contributes to favorable seeing conditions. We believe that pavement brightness patterns are important factors in night visibility on streets and highways.

Answering Mr. Keck's questions, the pavement area illuminated by the source and the area scanned by the receiver were kept equal to each other during all measurements. A narrow beam was projected on the pavement; the spot on the pavement was the source of light seen by the receiver. Dull black cloth absorbed the stray light. Several readings and measurements were taken for each position of the source and receiver with the pavement sample oriented as it was on the highway when seen by the vehicle driver looking directly ahead. The sample was not rotated in a horizontal plane to show the influence of "directional grains." This influence might be one of the reasons causing the curves to cross each other in Figs. 4, 7 and 11. As Mr. Schrenk points out, roughness of pavement, nonuniformity of texture and experimental errors probably have entered into the results. These factors may explain the shape of some of the curves.

Table I on page 70 should be used for relative comparisons only. These data are valid only for the three pavement samples which have been subject to known traffic conditions for a number of years. The brightness factor ratio of 7:1 between the dry and wet concrete can be explained by the relatively smooth surface, when wet, presenting preponderantly specular reflection. The asphaltic concrete on the other hand, having a much rougher texture, shows less specular reflection in the wet condition and, therefore, the brightness ratio is less.

To determine the amount of specular reflection and reflected glare for dry, damp and wet conditions, we hope to extend the range of horizontal angles in later measurements. We chose to define the damp and wet conditions of our samples as follows:

Damp — moist surfaces with pits being moist but not filled with water, with the texture quite perceptible.

Wet — surfaces covered with a film of water filling the pits and surrounding the vertical projections.

In reply to Mr. Marsh's comments, it is true that in order to apply our data we have to compute or to know the horizontal illumination. In some cases it may be desirable to have the brightness factors in terms of incident beam candlepower, but more and more the iso-lux curves are becoming available from manufacturers and other sources.

With reference to the discussion of Messrs. Toenjes and Reid, the ratio, candles per sq. ft / lumens per sq. ft called "brightness factor" in our paper, has a solid angular dimension, while the ratio footlamberts/footcandles called "brightness coefficient" by Professor Krachenbuehl (Reference 3) is dimensionless. A "brightness coefficient" could be obtained by multiplying the "brightness factor" by π. This would be the ratio of footlamberts/footcandles for an equivalent perfectly diffusing surface. Such an assumption, unfortunately, cannot be made about pavement textures.

The method and technique described in our paper for brightness factors at low angles of incidence and reflection, constitutes a complement to Professor Krachenbuehl's investigation on pavement brightness. The total body of data which will be obtained with combined efforts of these two investigations should constitute a useful addition to the Street Lighting Practice as suggested by Mr. Halvorson.

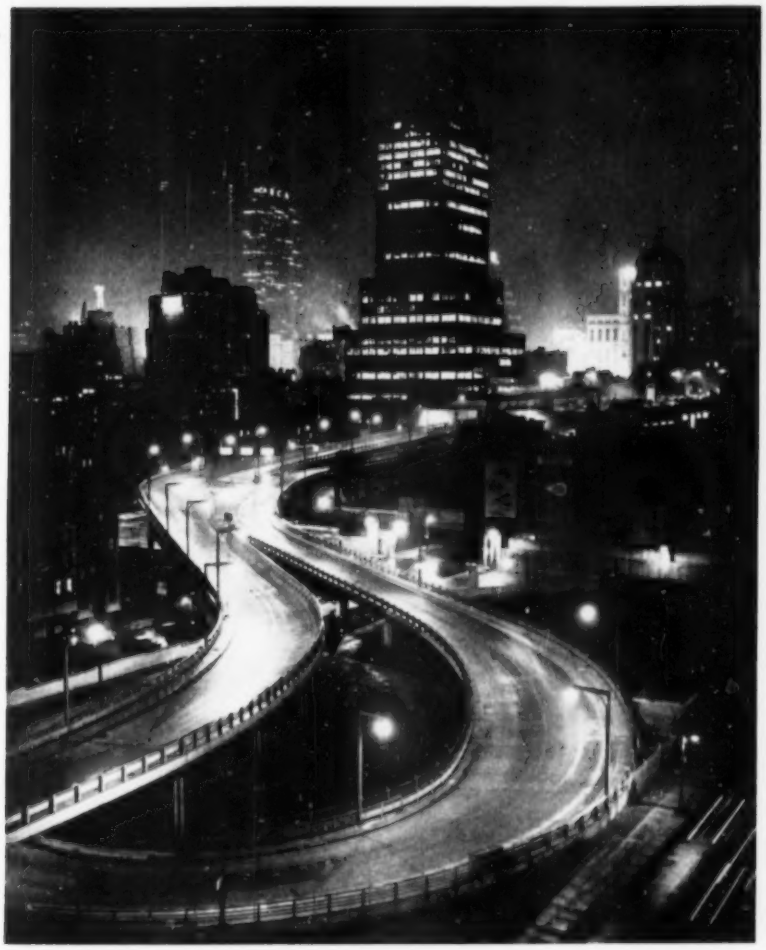
It is emphasized that special reflecting curbs and special median strips are helpful to the vehicle driver in his perception of the road and lane edges. However, on important highways shoulders are provided and continuous reflecting curbs or continuous reflecting median strips are not economically feasible and may also be tiresome to the vehicle driver on a long trip.

We concur with Mr. Swetland, that the final objective of pavement brightness research is to provide information to enable engineers to use roadway lighting equipment to produce a predetermined pavement brightness pattern giving the maximum degree of visibility.

I.E.S. Emblem

The official emblem of the Illuminating Engineering Society is available to members in 14-karat gold, lapel screw back buttons, in the miniature ½" size, at only $3.50 each including taxes. Blue background for Members, red background for Associate Members. Order from Illuminating Engineering Society, General Office, 1860 Broadway, New York 23, N. Y.

*Authors.



INSTALLATION ON RAMP BETWEEN LINCOLN TUNNEL AND PORT AUTHORITY BUS TERMINAL, NEW YORK CITY.

Lighting an Elevated Roadway

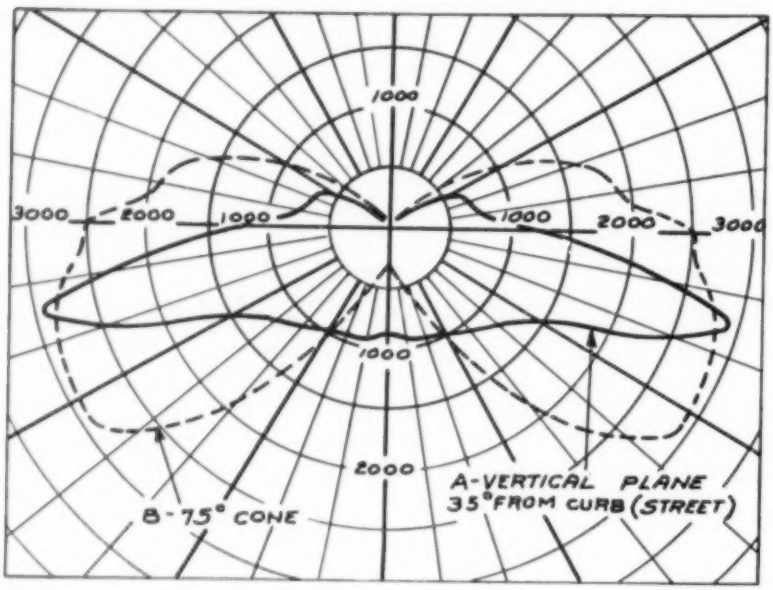
LIGHTING OBJECTIVE: To provide suitable roadway illumination for heavy bus and automobile traffic, in a distinctive manner to identify the ramps with the terminal.

GENERAL INFORMATION: The overhead ramps connecting the Port Authority Bus Terminal in the City of New York with the plazas of the Lincoln Tunnel provide a 1500-foot high-speed artery used daily by thousands of buses and passenger cars entering and leaving the bus terminal and its parking roof. The roadway width varies from 22 to 33 feet.

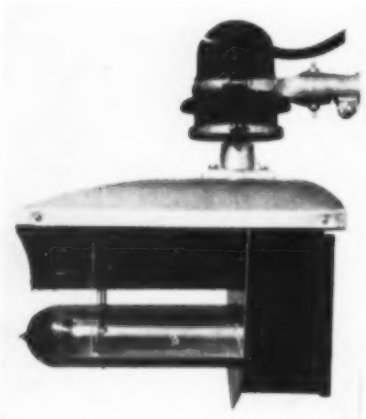
INSTALLATION: The sodium vapor luminaires employed on these ramps provide a ribbon of yellow-orange light leading to the bus terminal, a striking sight in contrast with the myriad of white incandescent filament light sources visible in the vicinity. General Electric Type M-2 No. A80G38 luminaires with 10,000-lumen (180 watts approx.) Type NA-9 sodium vapor lamps are mounted 24 feet 5 inches above the roadway. Average spacing is 80 feet. Bracket arms are 8 feet 6 inches or 7 feet 6 inches long depending on the location. A suspension mounting between the bracket and luminaire absorbs the vibration of traffic on the ramps.

(over)

A.I.A. File No. 31



Initial candlepower distribution in two planes.



Close-up of luminaire.

Illumination levels are as follows:

Calculated minimum	0.98 ft-c
Calculated maximum	1.65 ft-c
Average measured (approx.)	1.5 ft-c

Lighting data submitted by Wilfred Henschel of the Port of New York Authority as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, New York.

Characteristics of 300 Degree White Baked Enamel Finishes

By FRED E. GUTH

DEVELOPMENTS in and usage of baked enamel finishes in all fields, has come about during the "Fluorescent Era" — from 1938 to the present. First, fluorescent is a "cool" light source. With its relatively low operating temperature and low wattage, the fluorescent lamp greatly minimizes the problem of heat dissipation in lighting fixtures. Maximum lamp temperature, at lamp ends, will run from 100 to 115F, quite cool for the present 300-degree baked-on enamel.

Fluorescent, and later slimline, brought to the lighting industry a brand new problem. No fixture manufacturer was quite used to handling four-foot, six-foot, eight-foot and ten-foot items. Cartons and packaging were difficult. Contractors had to learn to handle the new "lighting monsters." This new element of size brought to the industry additional new problems of finish application, durability and adhesion. A finish was needed that would withstand bumping, bending of the metal, something really tough. Adhesion, stability and durability at their best. And at relatively low cost.

Finally, fluorescent sources required reflector finishes of higher reflectivity and better retention of color than was available from such finishes at that time. During the past 15 years, baked enamel "whites" have steadily been improved from a reflectivity standpoint. In 1938, a good R.F. for baked finishes ran 75 to 78 per cent. Today they exceed 90 per cent. Along with efficient reflection, similar advances have been made in color retention. We might point out, in this connection, that the lighting industry was not alone responsible for the progress made in the synthetic enamel field. A demand for better finishes was made from the appliance industry, for instance, where only porcelain enamel was at one time considered good enough for a top quality refrigerator. Today, with the advances in the synthetic fields, some 97 per cent of all the refrigerators produced are finished with 300-degree white baked enamel.

Let's review for a moment the primary reflector finishes when only the incandescent lamp was available. Heat was, and still is, the criterion in the selection of reflector finishes for use with incandescent lamps. First there was porcelain enamel, which dates back to the earliest days of the "lighting fixture" as we know it. Next came prismatic and silver-mirrored glass reflectors. Then the Alzak aluminum process was developed about 1933. These four heat-resistant finishes had their place then, and each of them is still important to the lighting industry today. There were practically no satisfactory organic finishes available until 1925, when the clear lacquer "Porceleen" came along. Wherever an all-white reflector was needed, porcelain enamel or air-dry whites served best for the smaller lamp fixtures.

Air-dry white enamels were most commonly used by fluorescent equipment manufacturers in the earliest fluorescent days. The problems at hand, however, were poor adhesion of the paint and lack of color retention. The drying type oils and metallic driers necessary with air-drys do not have as good long-time color retention properties. Discoloration was easily caused by direct and indirect sunlight, or by long exposure to atmospheric gases. And the paint wouldn't stay on, partly due, incidentally, to improper cleansing of the base metal.

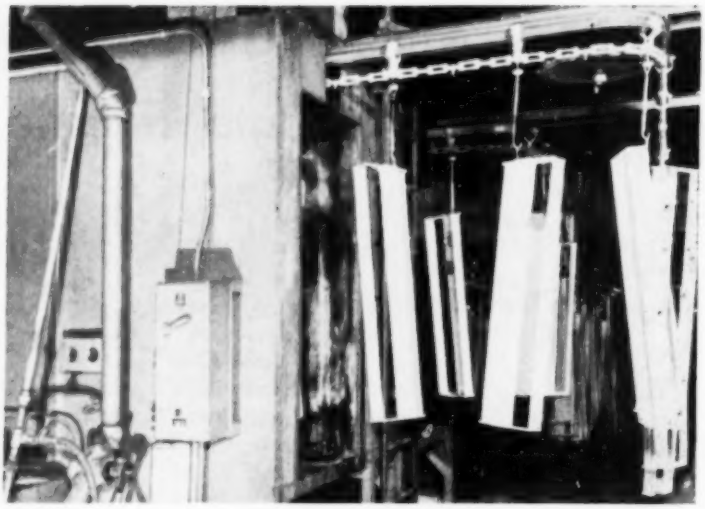
Most equipment manufacturers turned to baked-on enamels in an effort to solve these problems. As this was early in the development of enamels specifically for baking, paint manufacturers worked hand in hand with the lighting fixture people in producing new finishes with the necessary production and service characteristics.

Between 1935 and 1940 substantial improvements were made in organic finishes. Then it was that the alkyd type organic resins were developed. Their baking potential, hardness and corrosion resistance were improved by modifying them with urea formaldehyde and other nitrogen resins. During the past 12 years, new resin developments have made it possible to achieve hardness and durability characteristics at much shorter baking schedules than was possible a few years ago. Higher reflectivities have also been achieved, as well as new and different lighting effects obtained by varying the gloss of finish.

Another important contribution back in 1935-1940 was the use of straight titanium dioxide white pigment. These new resins and pigment, when

AUTHOR: The Edwin F. Guth Co., St. Louis, Missouri.

Early metal cleaning operations were mainly manual. This is a typical hand-dip tank for cleaning reflectors.



This completely automatic washing and phosphatizing plant is over 40 feet in length. The product comes from it clean and with an iron phosphate coating for maximum adhesion of enamel.

baked convert into a high gloss, high reflectance surface unaffected by common atmospheric conditions, and retain these characteristics over long periods of service.

Pre-application Preparation

For high quality finishing with any enamel — baked, air-dry, or porcelain — a basic requirement is the proper treatment of the metal to be coated. It stands to reason that machine-lubricants, dirt, grease, and even finger-prints of the workers, will have an adverse effect on the adhesion of enamel to the surfaces.

Early method for cleaning were relatively crude. Stacks of reflectors were dunked into "mineral spirit" baths. Naphtha was a favorite cleaner, but dangerous. Mass production methods had not been developed for the lighting equipment industry, and hand labor "human error" was always a factor.

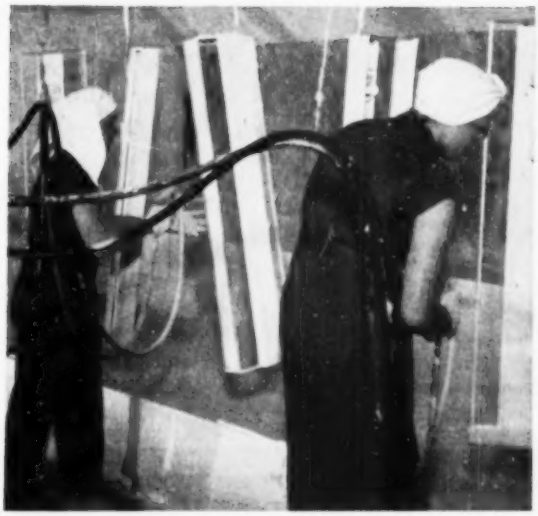
Boiling chemical compounds, such as Oakite, eventually supplanted the mineral spirits and did a better job. Still there was no mechanical knack in cleaning—still the human error factor was present.

Next came the steaming vapors of trichlorethylene. Here was a definite improvement over earlier cleaning methods; however, the human factor remained, as automatic lines "dragged out" the degreasing vapors making it quite expensive to operate. And still, after the degreasing operation, there was always the hand wiping of each piece — again the human factor.

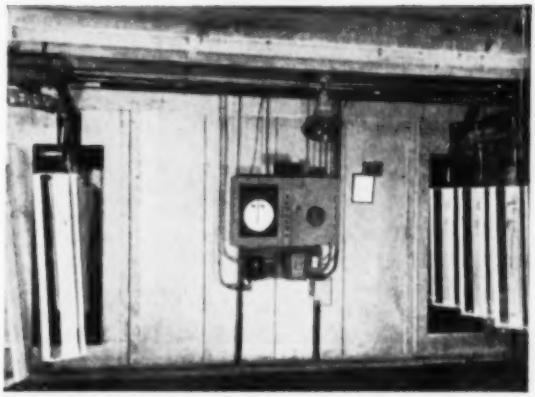
Today, this preparation of the metal is accomplished in large, fully automatic, washing and phosphatizing plants. In three or four different stages, these machines wash and scald the fixture and apply a deposit of iron phosphate to the surface to be finished. The product comes from this processing unit ready for coating. As shown in the accompanying illustrations, these giant industrial washing machines may approach a four-car garage in size and require the motive power of a 10-horsepower motor.

A proper treating of the base metal, as described above, is done of course, for more lasting adhesion of the 300-degree white finish. One step further is the bonderizing process which applies a finely etched phosphated surface, composed of "millions of little fingers" to hold the finish tighter to the metal. Bonderizing is another phosphate coating operation which in five or six steps coats the steel with a much heavier but finely etched phosphate surface.

The ultimate process for a top quality 300-degree enamel finish concerns zinc plating of the steel, either before or after fabrication of the fixture parts. The zinc plate need be only two-thousandths inch in thickness, yet this added protection can mean great savings to the user. Zinc plating is not a substitute for the cleaning and bonderizing process; it is a separate and added feature. Refrigerator manufacturers, soda water vending machines, as well as several lighting fixture manufacturers feel that this zinc plating operation is well worth the application cost, to insure permanent protection against rust even when the enamel itself has been scratched off.



Women sprayers coat fixture bodies smoothly and uniformly with enamel, against a background of the waterfall paint curtain of a modern spray booth.

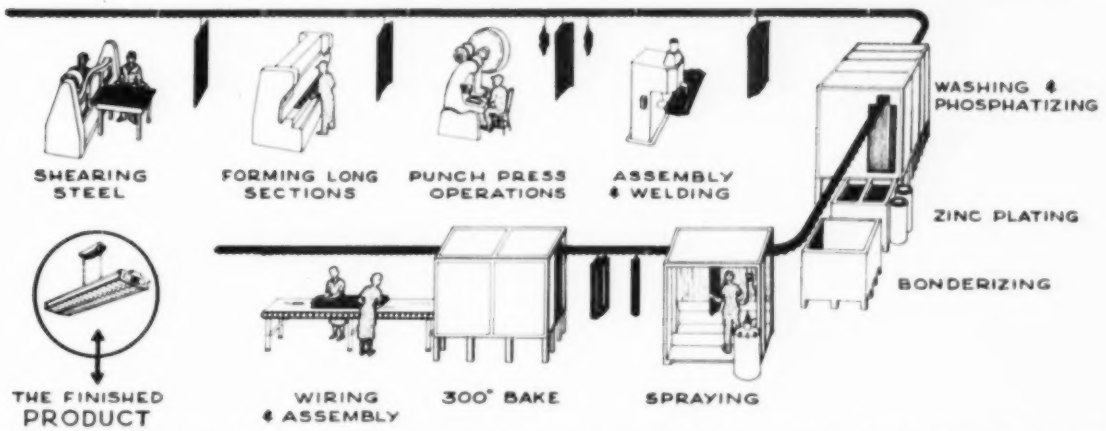


Production line conveyor carries fixtures into the convection type industrial oven where the enamel is baked into a durable, permanent finish. Inside the oven (below) the reflector units march down and back on either side of the row of burners running down the center of the oven.

Coating and Baking

Good mill steel is smooth surfaced; fabrication may cause slight scratches. Cleansing, zinc plating and bonderizing make that steel ready for its final treatment — spraying on the enamel. This is a process requiring great care — the enamel must be applied just right, to cover scratches, insure smoothness. Spraying on the enamel is practically an art. It requires an ever-alert mind and a constant desire on the part of the individual to do a perfect overall job. Women sprayers seem to do the best job; they take more interest in the work and aren't so "mechanical."

The good sprayer "lays" the enamel on the work just so, keeping it smooth and uniform. There can

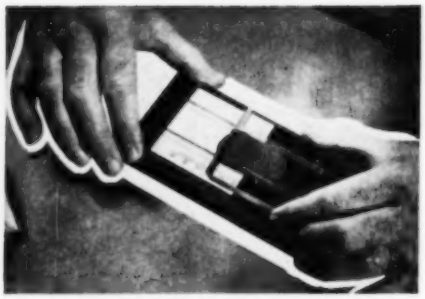


Pictorial representation of the production line in a modern luminaire plant shows the relationship of pre-coating and enamelling operations to the complete manufacturing process

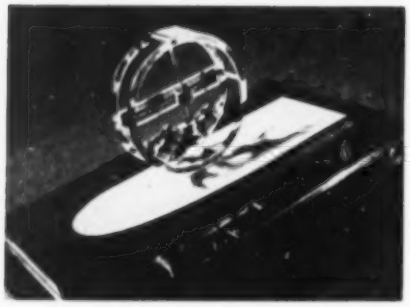
Some Quality Standard Specification Tests

Humidity cabinet for resistance to blistering and moisture.

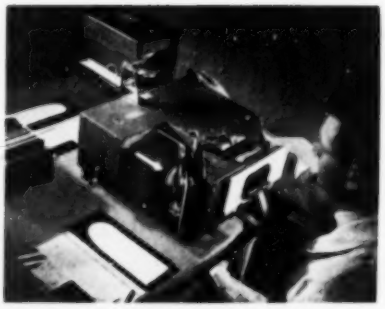
Weathering cabinet for rate of fading and chalking.



"Cryptometer" for hiding power.



Sward hardness rocker for surface hardness.



Hunter reflectometer for color differences and reflectivities.

be no runs and drips. The sprayer must have the skill to mix the enamel and thinner properly to get that "just right" paint flow, to cover the surface evenly and completely. Because the sprayer is guided by the visual appearance of the work as it progresses, good lighting in the spray booth is as good an investment as any labor-saving device that can be installed. Here is where good visibility is really important.

Over the years, spraying has been improved through the development of light-weight, adjustable spray guns; heated paint tanks that insure a smoother flow of paint; and roomier spray booths of improved design.

Electrostatic spraying, fully or semi-automatic, using high voltages (over 100,000 volts) to carry enamels to the work, have been developed. During the war, the electrostatic process was responsible for finishing thousands of war items. Experience seems to dictate that with the variety of design of reflectors, as well as the deep depressions of some fixture parts, the electrostatic application is somewhat limited at this time. Undoubtedly this great development will be improved to permit more versatile procedures.

Convection type ovens, as opposed to ovens of the radiant type, are more practical in present-day fixture processing since they permit the baking of a wider variety of product designs. This is true because the circulating atmosphere of hot gases in a gas or oil-fired unit bathes all surfaces of the product, no matter how complex its shape may be. Radiant infrared ovens, using heat lamps, have many advantages where the size and shape of the product can be standardized, and, like electrostatic spraying, they may see much future use in the lighting equipment industry.

Quality Standard Specifications

The reflectivity of an enamel can be easily specified from testing laboratory lighting data. From there on, the proper adhesion and durability of 300-degree enamels is difficult to specify or at least no effort is usually made to do so. A brief outline of such specifications may read as follows:

Enamel: The total non-volatile content of the enamel shall not be less than 60 per cent at a minimum weight per gallon of 10.20 pounds.

Humidity Cabinet: Suspend sample in cabinet at 110F, with relative humidity of 100 per cent. Should withstand 1000 hours. Determines resistance to blistering and moisture.

Salt Spray: Scratch an "x" on test panel. Subject to 20 per cent solution of sodium chloride at

90F temperature. After 200 hours, samples should not show blistering, crazing or cracking.

Flexibility and Adhesion: Bend test panel over 180-degree arc. Drop 3.3-lb. weight from 21-inch height. Should show no cracking.

Hardness: Take sharpened drawing pencils varying from 6B to 9H. Run pencils at 45-degree angle over samples. Type pencil that breaks film is taken as the hardness of the film. Should withstand "H" hardness lead.

Abrasion: Test sample should withstand 18,000 strokes on abrasion resistant machine before running through one mil of enamel finish.

Mar Resistance: Fingernail test. Should not leave any surface blemish.

Color Retention: Long time test under controlled diffused light and under exposure to total darkness.

Reflectivity: Use Hunter Reflectometer with green filter. Should be minimum of 89 per cent. Magnesium oxide standard equals 100 per cent. Complete data regarding above is available in booklet form from leading enamel manufacturers.

Reflector Design

When used as a reflecting surface, 300-degree white baked enamel is primarily for diffusing lighting as opposed to controlling the light rays. From 10 to 15 per cent (depending on the degree of gloss) actual direction or control is possible by reflector design, but generally speaking 90 per cent of the light is redirected in all directions.

In designing a reflector for use with 300-degree white, one rule of thumb is that greater size means greater efficiency. One should take every advantage of the 10 to 15 per cent light control possible, but from there on, a good wide open bottom, and reflector sides not too close to the lamps assure high overall light output.

Summary

With the problems of durability and adhesion solved, baked enamel finishes bring a wide versatility to the lighting industry. Their surface characteristics can be varied in diffusion from a high gloss to a dead matte; they can be pigmented with almost any color, including aluminum and statuary and satin bronzes; and in white they can be made with reflectances up to 90 per cent. These finishes are ideally suited to the majority of fluorescent fixture types, and scratches and other handling damage can be satisfactorily touched up on the job. Baked enamel finishes combine good quality with reasonable cost.

Acknowledgments

The author wishes to thank Mr. O. J. Spawn of the DuPont Company, Chicago; Mr. John Piel of the Glidden Company, St. Louis; Doc Koegel and Ed Guth, Jr., of the Edwin F. Guth Company, St. Louis, for their fine assistance.

[EDITOR'S NOTE: This is the third in a series of articles on the characteristics of materials used in the lighting industry. "Characteristics of Plastics" and "Characteristics of Porcelain Enamel" were published in the December 1951 and July 1952 issues respectively. Future articles may include glass, acoustical materials, Alzak aluminum, etc.]

Coffers in a Corridor

Three circular recessed domes with 200-watt silvered bowl lamps provide ten footcandles in this corridor at the Milwaukee Athletic Club, Milwaukee, Wis. The corridor measures 28'6" by 7'8" with an 8'6" ceiling. Ceiling is white with a border of tan and green bands; walls are natural brown wood, and carpeting is chartreuse. Illumination at the telephone booths is 15 footcandles, from custom-built recessed units equipped with 60-watt lamps. The units are held by pressure clips and pull out for relamping. ***Photo courtesy General Electric Co., Cleveland.***

Lamps and Lighting— A Vision of the Future

By J. N. ALDINGTON

IT IS practically always unwise to try to forecast the future. This is true of human affairs, of the relations between nations and it is true in science and the arts. I therefore want to make it clear that in selecting the title "Lamps and Lighting — a Vision of the Future," I shall be attempting to draw conclusions from the present state of the art rather than to predict possible developments from premises which must be at the best uncertain.

Let me first of all ask you to look with me at the incandescent electric lamp. Developments in this field have ceased to be dramatic. This can be due to one of two factors, either we are approaching an upper limit of efficiency for a given designed life for each of the normal types of lamp, or we have become hide-bound in our thinking, and because we are travelling along well worn tracks, have failed to strike out in fresh directions which may lead us to hitherto unsuspected possibilities in the production of incandescent light. Let us look at each of these possibilities in turn.

The filaments of our incandescent lamps are made from tungsten, an element with a melting point of 3655K. For each type of lamp whether it be of vacuum coil design for traction purposes or a single or a coiled-coil gas-filled lamp, or whether it be one of the many different designs of high brightness projection lamps, there is a maximum average efficiency obtainable by the best manufacturers for a given designed average life. Developments in the last two or three decades have proceeded in the direction of reducing the spread between individual lamps and the spread between batches of lamps made by different manufacturers. As a result the average quality of this class of lamp has gradually but steadily been improved. In this connection it is worthy of note that lamp manufacturers all over the world at an early stage in the evolution of the industry recognized their separate and joint responsibilities for promoting the production and development of the best possible sources of light.

Exchange of information among the lamp companies has therefore proceeded freely for many years and the main differences which still remain in the quality of tungsten filament lamps as between different manufacturers are not generally those due to differences in "know-how" but are due to differences in the extent to which local circumstances make it possible to take advantage of the optimum conditions of manufacture which alone can lead to the highest quality. Developments in stable glasses, in the production of pure gases, in vacuum physics, and in the metallurgy of tungsten, have all contributed to this end.

Having in mind these things, it is good to be able to reflect and record that in the electric lamp industry the endeavour of all reputable manufacturers has always been to strive after the optimum performance. It is recognized that this optimum performance in the case of tungsten filament lamps is governed by the nature of the materials with which we have to deal and with the physical factors involved in the construction of the lamp. It is a function of the vapour pressure characteristics of tungsten under the conditions which obtain inside the lamp. It is a function to a lesser degree of the unavoidable losses due to conduction through the leading-in wires of the lamp and the filament supports, losses due to conduction and convection in the gas-filling and the slight loss due to absorption and total internal reflection at the face of the glass bulb and that due to the solid angle subtended by the cap. The evaporation characteristics are also to some degree affected by the surface condition of the tungsten wire used for making the filament and hence by the composition of the wire itself, its crystalline structure and its surface condition. The thermal losses due to the gas-filling are influenced by the gas pressure and the percentage of argon to nitrogen used in the filling. The maximum obtainable gas-filling pressure is generally always desirable and here the practical limitation is due to the need for pipping off the exhaust stem of the lamp at a pressure not greater than atmospheric or not very much higher. The higher the ratio of argon to nitrogen in the gas-filling, the higher the quality of the finished lamp, but with too high a ratio there is a liability to an increase in the gas current in parallel with the filament and to explosive rupture

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 8-12, 1952, Chicago, Illinois. DR. ALDINGTON is associated with Siemens Electric Lamps and Supplies Ltd., Preston, Lancashire, England.

due to arcing at the instant of failure. This is of course a problem which exists to a greater extent in Great Britain and Europe than in your country due to our use of 200- to 250-volt mains. The use of fused-in lead constructions for both single and coiled-coil lamps to enable higher argon ratios to be used is now being extended in various countries.

All these factors, however, are as mentioned at the beginning factors which can influence the final result by only a small amount assuming that the general lamp manufacturing technique is good and the technical control of the lamp making process is adequate at all stages.

Let us now turn to some considerations of the second of my two premises, namely, the possibility that by treading well worn paths, we may be missing some new avenue along which lies the means to produce a very material increase in the efficiency of the incandescent lamp. There can be no doubt that in the case of the comparatively low-wattage type of ordinary gas-filled lamp of either single or coiled-coil construction, an immediate improvement would result from the substitution of krypton for argon. This is of course well known. While supplies of krypton are now freely available from liquid air plants in various parts of the world the cost is generally prohibitive compared with the magnitude of the possible improvement in luminous efficiency for a given life.

A still greater benefit would result from the use of fillings of xenon. Here, however, the matter does not appear to even be remotely within the bounds of practical possibilities in view of the extreme rarity of this constituent of the earth's atmosphere. For special high-power high-brightness tungsten filament projection lamps, mercury vapour at high pressure either with or without xenon or other monatomic gas has definite possibilities and has been used in experimental designs with gratifying results. There is, however, no likelihood whatever that mercury vapour could be used as a gas-filling in anything other than very special projection lamps and the other design features which are simultaneously necessary makes this type of development very expensive.

Figure 1. Experimental mercury-filled high brightness tungsten filament lamp.

It seems unlikely that much further progress can be made in developing alternative filament designs such as triple coils for the tungsten filament gas-filled lamp nor is there much scope for still further reducing thermal losses at the filament supports and electrodes. It would appear, therefore, that the tungsten filament lamp will remain in its present form and will continue to be one of the principal light sources of the future in very many lighting fields for it must be remembered that in a very large range of lighting applications there is as yet no alternative source with anything like the desirable characteristics of the tungsten lamp.

We are forced therefore to look at the incandescent radiator itself. There is no metallic element likely to supersede tungsten as a filament material. We may, however, ask ourselves whether selective radiators of the type used in the original Nernst glower or of other types yet to be studied offer any possibilities. If we cannot obtain a higher filament temperature and therefore a more effective transformation of electrical energy into visible radiation by temperature alone can we either coat the filament with a material which emits preferentially in the visible region or can we produce a new type of filament made from oxides, carbides or other compounds of high melting point and low volatility or with selective radiation properties. It is easy to say that this field has already been investigated. It is perhaps more true, however, to reflect that the remarkable advances which have been made in the tungsten filament lamp have prevented serious work on these other possibilities which did not appear to offer such immediate reward for effort as continued studies of existing designs. If our thinking is to remain vigorous and fresh, we must not fail to re-examine methods which have been discarded long since — for now, and in the future, we have more powerful means at our disposal for investigation and research than were available to the pioneers of the decades that have passed.

Discharge Lamps

When we consider the electric discharge lamp we are on much less sure ground. Only in certain specific directions are we limited by the properties of matter. In other directions the free play of

research, development and invention will undoubtedly result in material advances in the efficiency, performance characteristics and life of electric discharge lamps.

Sodium Lamps. — The most fundamental limitation yet recorded in a practical lamp is probably that imposed in the case of the sodium lamp by the fact that the resonance doublet of the sodium atom is produced at optimum efficiency at a very low vapour pressure.

Movement in lamp design from the optimum condition in the direction of lower or higher vapour pressure or higher current density results in each case in a decrease in the luminous efficiency. There is thus set a limit to the maximum attainable efficiency of the order of 70 to 80 lpw for a lamp design in which the temperature of the containing vessel necessary to give the requisite sodium vapour pressure is obtained by heat absorbed from the discharge itself.

If one separates the heating effect of the discharge from the total power consumed by the lamp and thinks in terms of maintaining the requisite vapour pressure by external means, then still higher efficiencies can be obtained by suitable choice of the tube parameters including current density. So far, however, no practical lamp forms more efficient than existing designs which give initial efficiencies of more than 70 lpw have emerged from such considerations and it is unlikely that they will do so. In any case no practical modification of the sodium lamp has so far been conceived which can result in other than the emission of the practically monochromatic yellow radiation so well known to all of us without a serious loss in efficiency.

Mercury Vapour Lamps. — When we turn, however, to the range of mercury vapour lamps we see at once that the possibilities have by no means been exhausted. The low pressure mercury vapour discharge is a most efficient source of ultraviolet radiation in the region of 2537A, a characteristic utilized so notably in connection with the fluorescent lamp. When the mercury lamp is designed to operate at a pressure of between one atmosphere and ten atmospheres quite high efficiencies can be obtained and there are many designs of long life mercury vapour lamp on the market which operate at initial efficiencies between 40 and 60 lpw. Experimentally lamps have been made with initial efficiencies greater than 70 lpw but these are of types which at the present time have certain features which make them unsuitable for commercial exploitation.

Studies of tube design and particularly of electrode design have progressively resulted in better maintenance of luminous flux over life and in longer lives. There is no indication that the possibilities in these directions are exhausted. We can

Figure 2. Air-cooled short arc mercury vapour lamp

therefore look forward with confidence to continuous developments in the field of high pressure mercury vapour lamps for general lighting purposes as well as to continued development of special purpose high brightness mercury lamps.

The association of highly efficient phosphors with high pressure mercury vapour lamps has been practiced for many years. Developments are still taking place in this field and many improved phosphors capable of materially increasing the red and blue radiation from the mercury vapour lamp have been developed and their properties are being examined. Some of them have already found their way into mercury vapour lamps of improved colour and other characteristics. It is anticipated that there will be further material progress and that further new mercury vapour lamps with the colour modified both by the addition of other metals such as cadmium and zinc to the vapour phase and by the modifying effect of fluorescent powders on the inner surface of the outer bulb containing the discharge tube proper will emerge from the lamp research laboratories of the world. There is no indication of finality.

In view of the theoretical and practical developments in mercury vapour arcs as brightness sources, I propose to mention one or two points very briefly. The theoretical possibilities have been examined over a wide range of operating conditions and quite an extensive practical survey has been made of short arc high pressure air-cooled mercury vapour lamps from about 100 watts up to 50 kw loading. Brightnesses of the order of 1.5×10^5 candles per square centimetre have been obtained with a type M.E. lamp of 10 mm arc length loaded to 30 kw. With a similar lamp with the arc length reduced to 5 mm the brightness would exceed 4×10^5 candles per square centimetre which is more than twice the brightness of the sun's disc as viewed from the earth. It is necessary to emphasize that these are extreme conditions which lie somewhat outside the region of practical lamp engineering at the present time. They indicate, however, the remarkable flexibility of the mercury vapour arc as a light source and its potentialities. At the other

extreme, a 100-watt M.E. lamp with a 1 mm arc can be made with a centre arc brightness of 5×10^4 candles per square centimetre, a remarkably high figure for so small a lamp.

As far as I am aware there is no alternative discharge lamp offering so many design possibilities as the high pressure mercury vapour arc. It has been established that both the centre brightness *Bc* and the arc width '*w*' at half *Bc* may be expressed by simple relationships in which the only terms involved are:

L = arc length in cm
V = arc voltage
A = arc current

These approximate relationships are:

$$Bc \text{ (stilbs)} = 3.0 \times \left(\frac{V}{L}\right)^{1.5} \times A^{0.7}$$

and

$$W \text{ (cms)} = \frac{1.4 \times A^{0.3}}{\left(\frac{V}{L}\right)^{0.5}}$$

There are associated properties, however, which restrict the field of usefulness of these very high brightness sources. A restriction in particular is the requirement that the high mercury vapour pressure condition can only be developed by operating the lamp bulb at a high and even wall temperature. The bulbs are therefore made from quartz and a time measured in minutes is required before full brightness is attained. While this time can be reduced to a very short order by bulb preheating and by other means, the inconveniences of such additional arrangements have so far prevented many large scale installations of high brightness air-cooled mercury vapour lamps. The applications which have been found in a variety of optical instruments and for which the lower wattages of air-cooled M.E. type lamps are eminently suitable, however, point the way to further developments in the future.

The Gas Arc.—An interesting newcomer to the field of high brightness sources is the high current density xenon or gas arc. This type of lamp has two principal advantages over its forerunner the high pressure mercury vapour arc, namely, that full light output is obtained immediately the arc is initiated and, secondly, that the gas arc gives light of daylight quality which thus makes it suitable for both the projection and the taking of colour photographs. A disadvantage is the relatively low arc voltage drop. There can be no doubt that very few of the possibilities and potentialities of the gas arc have been so far examined. It is therefore reasonable to expect that the field of usefulness of such lamps will be extended in the future.

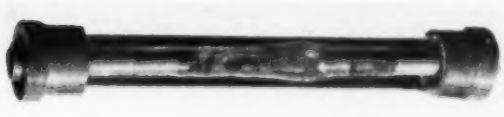


Figure 3. Original 5 kw gas arc lamp.

Fluorescent Lamps

In any continuous series of developments such as those which gave to the world the mains voltage fluorescent lamp in 1938, it is necessary at some stage to make decisions which rightly taken will influence the whole course of an industry for many years to come and it is a good thing if when that time arrives there are men with sufficient knowledge, experience and courage to make these decisions and abide by them.

By 1938 all the factors necessary for the production of successful mains voltage fluorescent lamps were known. Several suitable phosphors were available. Experience for a decade with aikaline earth oxide activated cathodes had shown the direction in which low current electrodes could be developed and the critical parameters of tube voltage and current were known from studies of the optimum conditions for the production of the ultraviolet resonance radiation from the excited mercury atom.

As a result, certain dimensions of fluorescent lamps were decided upon and while the range of lamps has increased since 1938 there has been no change in the principles which were then used to govern the decisions. There have been improvements — marked improvements — new phosphors have emerged, new phosphors are still being developed, electrodes have been improved with consequent improvement in lamp life and general lamp performance. Such changes as have occurred therefore, have been in quality and not in type. They have been evolutionary and not revolutionary. The fluorescent lamp has taken its place as one of the major lighting developments of the century. In cases of this sort we do well therefore, from time to time, to re-examine the position, to re-affirm the earlier decisions if an examination supports that attitude, or to determine alternatvely if there are new avenues which our preoccupation with the continued evolution of the present range of fluorescent lamps has so far prevented us from exploring.

It is not my purpose to suggest what these avenues might be. My thesis is directed as much to myself as it is to all other members of our Society. The fluorescent lamp has opened up such vast potentialities for good in the field of lighting that we would not be true to our heritage in the lighting world if we failed to re-examine from time to time

Figure 4. Interior view showing illumination of vertical surface.

the whole phenomena of fluorescence and our practical lamp forms, for while standardization is essential to the commercial engineer, absolute freedom is vital to the fertility of research.

Lighting

The remarks I have made in connection with lamp developments in the fluorescent field can be repeated with even greater force in connection with the application of light. From the oil lamps of the ancients, through the flickering flame of the gas burner, to that remarkable invention the incandescent gas mantle and on to the modern tungsten filament lamp, we see employed a principle which apparently enunciated that an artificial light source should be mounted in the region of the ceiling space and arranged to cast its light in a downward direction.

With the advent of the conception of brightness engineering, which after all is but a new description of a particular aspect of illuminating engineering, increased attention is being paid to the surface brightnesses produced by the lighting system and the lighting system is more and more being engineered to give desirable surface brightness and brightness ratios once the criteria for promoting efficient seeing and comfortable and pleasing lighting conditions have been determined. We are therefore branching away, I believe, from the continous line of development which I have referred to, along a new avenue and towards a new goal which I am convinced will result not only in more efficient illumination but in a greater appreciation by the general public of the material benefits which result from the proper application of artificial light. I can see no limit to the development possibilities in this field.

In this connection I would ask you for a moment to reflect on the visual scene under natural conditions. We tend to think of the sky as a source of overhead lighting and one object in very many lighting installations has been to simulate this conception by the regular placement of lighting fittings to produce a pattern of relatively bright sources over the entire ceiling areas. But if we look again at the visual scene outdoors we realize that in fact the illuminated area has the effect of the projection of a vertical surface at right angles to the plane of vision and that because of the curved surface of the sky enclosing the earth and the upward cut-off of the visual mechanism due to the bony structure of the forehead, we are not indeed conscious of overhead illumination at all, although it of course makes its appropriate contribution to the overall effect.

If now we turn our view indoors and contemplate the brightnesses of the surfaces inside a room provided with adequate daylighting from vertical windows in the wall surfaces, we find that it is the walls and not the ceiling which provides the bulk of the reflected light. The illumination from the ceiling is of a secondary order and the ceiling brightness derives its intensity from the walls, the floor areas and the room contents, if those are sufficiently light to contribute materially to the diffusion of the incident flux.

It therefore seems to me that our thinking should be directed towards a more positive approach to the production of illuminated vertical wall surfaces in those cases where the room geometry allows. We need to stress more the horizontal component of our illumination systems rather than the vertical component. For such purposes one could hardly wish for a more desirable light source form than that of the fluorescent lamp. Such experiments as I have personally been concerned with in this type of development have led to most pleasing lighting effects. Not only is the result of producing room illumination by the illumination of vertical surfaces efficient from the point of view of reducing objectionable shadows, it is also pleasing in giving a sense of space and openness to the illuminated interior which is surely a desirable objective for the illuminating engineer. By the production of adequate vertical surface illumination, ease of seeing is promoted and at the same time the lighting has the valuable aesthetic quality of producing good modelling of form and feature. I realize that in the Americas, the approach to this problem of home lighting has evolved in the direction of the extensive use of table and floor standard lamps. But I am unrepentant in advocating the radically different approach illustrated.

As we return to the outdoor scene and re-study

Figure 5. Outdoor scene showing partial silhouette and brightness contrast. Distant objects are seen in partial silhouette whereas near objects are seen as a result of their own detail in brightness and colour contrast.

it with the thought in mind that the major sky area appears to consist of an illuminated vertical surface, we realize that distant objects are seen in partial silhouette whereas near objects are seen as a result of their own detail in brightness and colour contrast. It is this property of the outdoor scene which gives to it its character and beauty and which has become so familiar to us as to pass almost unobserved. We do not reproduce this effect or simulate its beauty by merely directing light from ceiling-mounted lighting fittings or from standard lamps or isolated points. It is only when we realize the importance of the vertical surface, and indeed its dominating influence as a low brightness source, that our illuminating engineering comes truly into its own. I believe that this is a factor which has long been recognized in connection with theatre stage lighting. The transformation from the gloomy effects produced by overhead lights to the modern practice of using a very high component of horizontal illumination results in the vertical surface illumination characteristic of the best stage lighting practice and to the charm and beauty of the lighted theatre scene.

Outdoor Illumination

The most important single outdoor lighting application is that of street lighting. It is an aspect of illuminating engineering which is of the first importance not only on account of road safety but also because good public lighting materially increases the amenity aspects of our towns and cities at night.

We have moved a considerable way from the conception that isolated points of light constitute good lighting although it should be noted that in many parts of the world little practical progress has been made from this early conception except in isolated instances. In the best practice at the present time as much as possible of the available luminous flux is directed on to the road surface at angles which will produce in the eye of either the pedestrian or the driver of the motor vehicle a luminous background against which objects are revealed in silhouette. In this way it is considered that the best utilization of the power available for street lighting can be effected. We have thus moved through three principal stages in the history of man's endeavours to conquer the night in his nocturnal wanderings.

The first stage was the one in which torches or other illuminants were carried by the travellers themselves to reveal otherwise hidden pitfalls in their path. The second stage, which still exists very largely in many parts of the world, is the one in which relatively isolated sources of light produce pools of illumination in otherwise dark roadways. The third stage represented by the best practice is the one in which the highway is lighted in such a way as to produce in the eye of the observer a brightness pattern sufficient to allow the safe movement of traffic even at high speeds. I am not now concerned with the various means by which this desirable objective is achieved.

It seems to me that there is a fourth possibility and one which may come within the realms of practical politics in the future due to the advent of

high-power highly efficient light sources. It is the possibility of generally illuminating a town from light sources mounted at much greater heights than are commonly used today. Already in Great Britain one or two interesting preliminary experiments have been carried out. Under conditions in which the light source is outside the normal field of view of the observer, good visibility results from much lower illumination levels than are necessary where the eye has to contend not only with the brightness of the road surface, but also with the brightness of the sources producing the road illumination. This is of course a phenomena well known to those who have travelled in open country by clear moon light only. It is an aspect which I commend for further study on a practical scale.

Within the lifetime of most of us, the mounting height of lamps used for public lighting has been increased from 10 feet or so, up to about 25 feet, which is a figure used in Great Britain for Class A public lighting installations. The benefits which resulted from this change were most noteworthy in the production of better and safer road lighting conditions. There is, in the author's view, however, nothing sacred about the decision to use a 25-foot or 30-foot lantern mounting height. The policy was no doubt dictated by the practical difficulties of mounting at materially greater heights. With much greater heights for the light sources the spacing between sources would be increased very materially and much higher wattage lamps could be utilized at each point.

I will conclude, therefore, by making the plea that particularly where new public lighting is to be installed and especially in connection with the planning of new towns or urban areas, consideration should be given to the concept of general town illumination by light sources of high power, mounted at considerably greater heights than is common practice today and that the town planning itself should take into account of the lighting needs just as it has learned to take account of the needs for such other essential matters as drainage, water supply, electricity and all those other public amenities which we accept today as of right. The public has the right to the best lighting that we can at present provide and to all the developments which await us in the future. We are on the threshold, I believe, of a new era in the application of artificial light and of a new impetus in the furtherance of these broad humanitarian principles which underlie and should stimulate the work of every member of our Society.

I appreciate the opportunity which has been afforded to me of expressing my mature convictions on a number of matters affecting the future of lamps and lighting. I have spoken of what I truly believe to be the possibilities which lie immediately ahead of us. They are possibilities evolving from the practices of the present day. Beyond that, no man can say.

DISCUSSION

WARD HARRISON*: It is indeed a pleasant thing to listen to a really informing paper by one of our good friends, and a distinguished authority, from overseas, and not only do such interchanges make their contribution, large or small, to closer relations with other lands but, also as in this case we have an opportunity to learn much more than by just continuing to listen to ourselves talking to ourselves.

Dr. Aldington's statement that we may be missing new avenues in incandescent lamp development by retreading well worn paths is certainly an intriguing one. For example, has the Nernst glower principle really been sufficiently re-examined? Dr. Aldington reminds us too that the maximum obtainable gas pressure is generally desirable in a tungsten lamp but is kept down by the need for pipping off the exhaust stem. I would like to ask how much would be gained by doubling the customary pressure. It seems to me that the industry has surmounted greater problems than this one of pipping off the stem.

Dr. Aldington mentions that no alternative light source seems to him to offer so many possibilities as the high pressure mercury. This is certainly true for special applications but I would like to ask whether for general lighting the efficiencies obtainable are likely to exceed that of the fluorescent lamp.

The author makes the most effective case that I have heard for having the predominate light flux horizontal in direction so as to accent vertical rather than horizontal surfaces. I rather question the success of this proposal as applied to strictly utilitarian lighting but certainly from the aesthetic view there is much in its favor. For example, can you visualize a room with an open fire suspended in a basket just beneath the ceiling with, of course, a flue directly above it? Such a fire would retain the interest of the living flame but it would lose much of the charm of our present fireplaces which is due, in large measure, to the direction of light and the long, interesting shadows which are cast.

I should like to propose that at the conclusion of the discussion a formal vote of thanks be given to Dr. Aldington for his most interesting paper

M. N. WATERMAN**: Dr. Aldington's plea, in his very stimulating paper, for a more positive approach to illuminated vertical wall surfaces is congenial to what I noted in a very brief visit to England and the Continent this spring. I noted a strong interest in what I would call the "acceptability" of lighting as a criterion in addition to simple conformity to certain specifications as to footcandles and brightness ratios. By "acceptability" I mean an effect which is comfortable in the sense of giving aesthetic pleasure in addition to lack of pain. For example, many of you are familiar with the studies by Mr. Kalff in Holland of the most acceptable pattern of color and brightness on a wall panel in front of a jury of observers. As I recall it, the observers are given opportunity to adjust both color and brightness of surroundings to a visual task before them and to vote for their preference from the standpoint of their

*Consultant, Cleveland, Ohio.
**Westinghouse Electric Corp., Bloomfield, N. J.

feeling of well being. In Europe I saw installations of the so called "cut off" system of street lighting in which the street lights are shielded to a much lower angle below the horizontal than is usual in the United States. While I realize that this "cut off" lighting is more costly and less efficient in an engineering sense, nevertheless I found it very comfortable and pleasing. I think this approach to street lighting is another instance of experimentation toward comfort in the meaning I have described.

I, for one, am grateful to Dr. Aldington for the recommendation he has given us for more active thought about the lighting of vertical surfaces for greater comfort and pleasure.

R. G. SLAUER*: It is almost impossible to discuss objectively a philosophical paper such as Dr. Aldington's — if one really knew the trend of future scientific progress, he would be a very important man indeed. However, I have on specific comment to make — the suggestion that we who spend our time in applying light share with Dr. Aldington and other laboratories the burden of future lighting effectiveness. Efficiency is in some cases not as important as application utilization. This seems to be recognized by the author in that the second half of the paper does not mention efficiency at all while the first half is based on it.

Dr. Aldington does not paint too hopeful a picture of the future of incandescent lamps. Yet so many billions are in use that even small increments in efficiency are important. England's utilization of 230 volts instead of 115 is a discarding of over 10 per cent efficiency, more than the overall development advance in 15 years. If we in the U. S. should suddenly shift to 230 volts, it would cost us at least 70 million dollars per year in power costs alone. One is constrained to ask if progress can be isolated from practices which have grown around the product.

The thought is emphasized by an incandescent fluorescent comparison. The latter is only three times as efficient — less if ballast losses are considered. But in utilization efficiency it is 5-10 times as effective. Here one has the feeling that, relatively at least, the goal of better lighting through improved patterns of brightness, through spectral control, and so on, makes lamp efficiency improvement only half of a team.

New light sources such as the panelescent lamp also may be considered as an example of this thinking. For this source, incandescent efficiencies seem a terrific challenge, fluorescent efficiencies extremely remote. But its inherent characteristic of a large area source suggests that the direct production of 25-100 footlamberts may be a better way of reaching certain illumination goals than the modification of 2000- and 100,000-footlambert sources.

We are happy that the laboratories of England are working strenuously toward newer and better light sources. It gives us all a feeling that the limits of our profession lie wholly within our own power; as we learn more and more about what the eye needs and how, we will have the source tools for our goals.

JAMES M. MCCULLOCH**: Would you please enlarge a bit upon whether your suggestion for the lighting of vertical surfaces is offered in lieu of, or in addition to, the lighting of horizontal surfaces? I realize that you will probably want to make a distinction between various applications.

None of the several books on stage lighting with which I am familiar advocate specifically the lighting of vertical surfaces. They are, in fact, much more likely to emphasize the avoidance of lighting the back wall. While it is true that the audience sees the vertical surfaces of the actors' face and figure, I believe that the actors are made more visible in space by lighting from a diagonal, rather than by horizontal lighting flux. Might it not be well to emphasize an increase in flux other than vertical, allowing spilling on vertical surfaces, rather than emphasizing the lighting of vertical surfaces which might be interpreted by many as recommending the use of horizontal flux?

I thoroughly enjoyed this address and thank the author for it.

J. N. ALDINGTON*: May I first of all express the pleasure which has been mine in being asked to address this Conference. I have enjoyed every minute of it and particularly the contributions made to the discussion.

Many of the comments could no doubt be debated at considerable length with benefit to us all if time and space permitted. I will confine myself under the circumstances to dealing with the queries that have been raised.

I was most interested in the comments of Dr. Ward Harrison. A gain of the order of 10 per cent would be possible if we were to double the customary gas pressure in a gas-filled lamp. There is, however, an upper limit to the pressure which could be allowed as obviously a lamp with a cold filling pressure greater than 1 atmosphere would have an explosive potential when accidentally broken which would increase with increased pressure above that point.

With regard to Dr. Harrison's question on the high pressure mercury lamp, it was my intention to relate the design possibilities with this class of lamp to alternative plain discharge lamps and it occurs to me from the question that I must not have made this point clear. However, in reply to the question relating mercury lamp possibilities to those of the fluorescent lamp I am of the opinion that for general lighting mercury lamp efficiencies while of the same order are not likely to exceed fluorescent lamp efficiencies. For comparable wattage lamps they are likely to remain somewhat lower.

I am very grateful for the support of both Dr. Harrison and Mr. Marshall Waterman for my plea for a more positive approach to the accenting of vertical wall surfaces in appropriate surroundings.

Mr. Waterman mentions the European work on the acceptability of lighting systems. We in Europe, of course, for street lighting have what we consider very acceptable systems of street lighting employing the two extremes of cut-off on the one hand and non cut-off on the other. The general thought on street lighting in your country, if I have understood discussions with your engineers aright, is to work somewhere between these two systems. Of one thing I am sure, we shall all benefit by the interplay and interchange of ideas on these matters between members of your Society and the sister Society in England.

Mr. Slauer's comment on the use in England of 230-volt supply instead of the 115-volt used in your country misses I feel an important governing factor and that is the cost of the transmission lines and energy convertors for the lower voltage. This is such an overriding factor that it has recently been decided that the final objective voltage in Great Britain shall be 240 volts when it is ultimately found pos-

*Sylvania Electric Products Inc., Salem, Mass.
**Ballast Engineering Div., General Electric Co., Fort Wayne, Ind.

*Author.

sible to have a standard voltage throughout the country. The choice of 240 rather than 230 was I believe in part governed by the further saving in copper obtained by choice of the higher voltage. While therefore I appreciate Mr. Slauer's point of view regarding lamp efficiency, in our view the other considerations far outweigh the one he has brought up.

The utilization factor that he mentions is to my mind much more important, so often is the improved efficiency produced by years of work on lamp development brought to nought by poor utilization!

Mr. McCulloch has drawn attention to a lack of clarity in my presentation which came from the need to make a very broad survey in the short delivery time which was required by the organization of your Conference. Most certainly one has to distinguish between various applications in considering the relative weight to be attached to the vertical component of illumination and the horizontal. This point is of course brought out also in Dr. Harrison's contribution. What I have pointed out is that undue emphasis has been placed historically on the downward component of illumination presumably due to the consideration that the sky was overhead and therefore produced downward illumination. I have sought to show that it is the horizontal component of the sky's illumination which is by far the most important in producing the illuminated visual scene both outdoors and for the daylighting of interiors.

In general the practical factors involved in producing adequate illumination of vertical surfaces will ensure the simultaneous illumination of the horizontal surface — at least such has been by experience and I illustrated this point by mentioning stage lighting. I profess no special knowledge of this field. I would remind ourselves, however, that the quality of the visual scene on the theatre stage as viewed from the audience results from the colour and brightness contrasts produced by the horizontal component of whatever illumination is used. I entirely agree with Mr. McCulloch's statement of the case in regard to stage lighting that it would be well to emphasize and increase any flux other than vertical. This is of course a special example of the general case which I have sought to present to your Conference.

The Kinorama as an Evaluator in Aviation Lighting

Discussion and Rebuttal on paper by F. C. Breckenridge

(Published October 1952 issue of ILLUMINATING ENGINEERING)

DAVID C. MILLER*: Everyone hearing Dr. Breckenridge's presentation, or reading his paper, must be impressed by the imagination and ingenuity he has shown in developing the kinorama.

It is conceivable that the advantages which the kinorama may offer by "bringing the outdoors inside" will prove of extreme value in studies of aviation lighting. These advantages include enormous savings in both time and money, as well as an opportunity to control test conditions.

However, the findings of tests on "laboratory simulations" cannot be accepted as applicable to the actual problem until there has been proved adequate correlation between the studies in miniature and studies at full scale.

The author indicates his awareness of this limitation of testing in miniature. Nevertheless, the need to prove the validity and reliability of the kinorama measurements in evaluating the value to a pilot of an approach lighting system warrants further emphasis.

Studies at full scale need be no more extensive than required to provide a correlation of statistically acceptable reliability with the data from studies in miniature. Particular care should be taken to prove that the kinorama can predict the value of an approach lighting system since data collected in extensive field tests of approach lighting systems have been interpreted into incompatible findings by odifferent groups of experts, all generally considered competent.

I believe that the I.E.S. should encourage the author to continue development of the kinorama and ask that he report, when they become available, the data which will establish the kinorama as a proven evaluator of aviation lighting systems.

*General Electric Co., Cleveland, Ohio.

F. C. BRECKENRIDGE*: Mr. Miller's encouraging comments on the possibilities of the kinorama are very much appreciated and his emphasis on the importance of evaluating the evaluator before using it to evaluate lighting configurations is certainly pertinent. It is, indeed, because the validity of the kinorama tests has not yet been fully demonstrated, that the results on the comparison of the three approach light configurations have not been released for publication. We are now engaged in working out a program for testing the reliability and validity of the new prototype kinorama. In doing this we shall have the benefit of the advice of some of the psychologists who have had the most experience with pilots' problems of any in this country.

When the kinorama has been developed to show a satisfactory reliability and validity, we hope that it will prove of great value as a means of establishing the basic principles on which an approach light configuration should be designed and as a practical screening device for eliminating the present necessity for flight testing many ideas which turn out to be unsatisfactory. We can never hope to eliminate completely the need for flight testing as a basis for final approval. It would not be psychologically desirable to do so even if it were proved scientifically feasible.

As regards the divergent interpretation of the results of the flight test at the Landing Aids Experiment Station at Arcata, most of this was clearly related to the interpreter's association with a system which did not prove as perfect as he had hoped. No perfect system was ever found and it was never possible to carry out enough approaches to establish beyond possible doubt the relative values of offsetting merits and limitations. In this respect, the practicability of obtaining a much larger body of data with the kinorama is in its favor.

*Author: National Bureau of Standards, Washington, D. C.

A Lumen Method of Daylighting Design

Discussion of paper by R. L. Biesele, W. J. Arner, E. W. Conover

(Published January 1953 issue of ILLUMINATING ENGINEERING)

C. L. CROUCH*: The authors have tied the "illumination coefficient" to a system of empirical "window indices" which functionally correspond to room indices. Unfortunately, however, the authors were not familiar with recent work on room indices. They developed their window index in terms of (1) the ratio of room length to room width, and (2) height to width. However, these do not appear to be purely functional relationships.

Hisano[1] has shown that the equivalent square room width of a rectangular room is the geometric mean of the length and width:

$$\text{Equivalent square room width} = \frac{2 \times \text{width} \times \text{length}}{\text{width} + \text{length}}$$

This relationship has been applied to the Harrison and Anderson square room index concept

$$\left[\text{Room index} = K \frac{\text{width}}{\text{height of source above working plane}} \right]$$

producing the following equation:

$$\text{Room index} = K \frac{2 \times \text{length} \times \text{width}}{\left(\begin{matrix} \text{equivalent source height} \\ \text{above working plane} \end{matrix} \right) \left(\begin{matrix} \text{length} + \\ \text{width} \end{matrix} \right)}$$

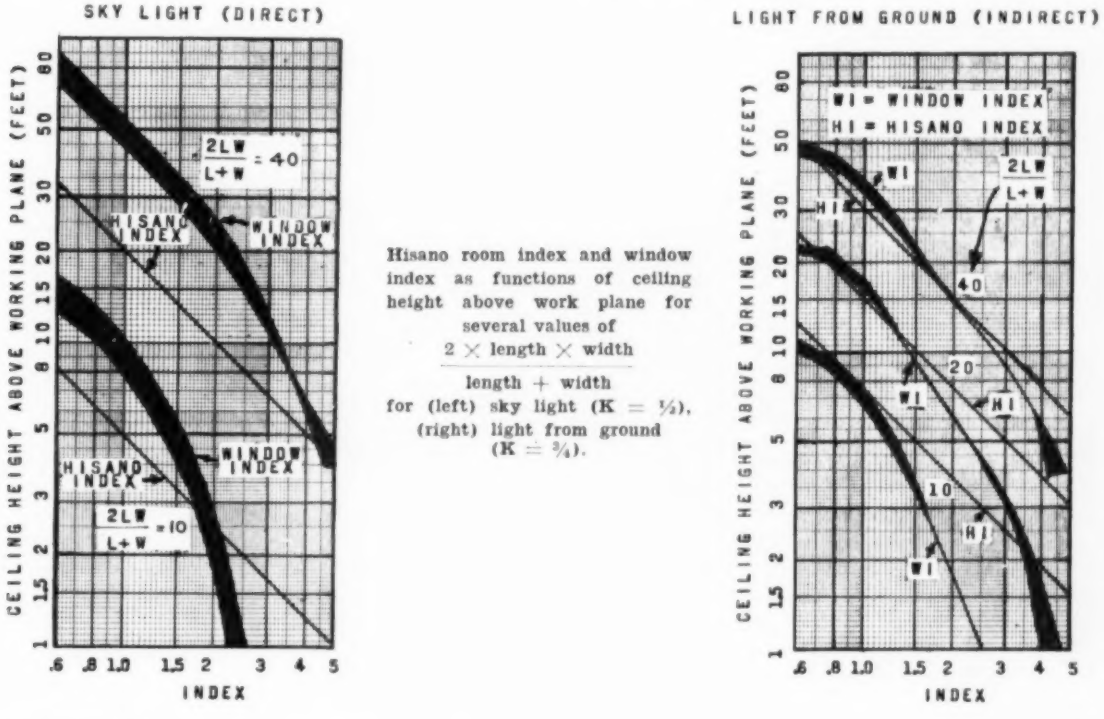
Assuming as did Harrison,[2] $K = \frac{1}{2}$ for direct lighting, and $K = \frac{3}{4}$ for indirect lighting, use of the above equations gives coefficients of utilization matching[3] the original Harrison and Anderson experimental data very well.

We believe that this equation, which has been shown to be functional for artificial lighting, should also apply to daylighting, using the *same constant* for both direct lighting from the sky and light from the ground reflected from the ceiling. (The validity of Harrison's assumption of different constants for direct and indirect lighting seems to break down when one considers indirect lighting versus direct luminaires installed in the ceiling, e.g., downlights or a luminous ceiling.) From measurements of direct sky lighting it appears that practically all the flux is thrown onto the floor, a distribution similar to artificial down lighting from the ceiling. Therefore, we suggest using the above equation to replace Figs. 2 and 3 in the authors' presentation, converting the abscissas in Figs. 4 through 7 to room index.

The accompanying illustrations show the Hisano room index and the Biesele-Arner-Conover window index each plotted against height for several conditions of equivalent room width. Note that in most instances there is a range of window indices for any one height. (However, a variation in window index from 2.5 to 5 would produce a maximum change in illumination coefficient (for average illumination) of only 20 per cent).

*Technical Director, Illuminating Engineering Society headquarters, New York, N. Y.

1. Hisano, K.: "Light Flux Distribution in a Rectangular Parallelepiped and Its Simplifying Scale," ILLUMINATING ENGINEERING, Vol. XLI, p. 232 (March 1946).
2. Harrson, W., and Anderson, E. A.: "Illumination Efficiencies as Determined in an Experimental Room," *Transactions I.E.S.*, Vol. XI, p. 67 (1916); and "Coefficients of Utilization," *Transactions I.E.S.*, Vol. XV, p. 97 (1920).
3. Crouch, C. L., and Freyer, Eve: "New Formula for Room Index," to be published.



Hisano room index and window index as functions of ceiling height above work plane for several values of

$$\frac{2 \times \text{length} \times \text{width}}{\text{length} + \text{width}}$$

for (left) sky light ($K = \frac{1}{2}$), (right) light from ground ($K = \frac{3}{4}$).

Pointers in Entering Lighting Competitions

By JOHN O. KRAEHENBUEHL

The last ten years have seen a marked increase in lighting design competitions, sponsored on both a local and national basis as well as on commercial and professional levels. Since competitors wish to know how the judges contemplate the entries in these competitions, an effort is made to outline the points considered when an entry is being judged. The author has served on the Board of Judges for many major lighting competitions.

THE FIRST item of importance is consideration of the contest rules. Every contestant must first understand that it is necessary to accept the conditions established for the contest, even though in his judgment some of the requirements seem foolish or even ridiculous. If he wishes to compete he must follow the rules to the letter, for this is the first elimination test applied to an exhibit. Many excellent installations of a lighting system with painstaking preparation of the entry, have to be eliminated because they are a day *late* or some luminaire has been used which is ruled out of the competition.

Most contest rules have a clause limiting or restricting the *eligibility* of individuals. This arises from several influences. Usually employees of the contesting organization cannot compete, for their winning would reflect upon the honesty of the contest. Similar restrictions are frequently placed upon the groups sponsoring the contest. For the judges, one of the usual difficulties arises when an individual classifies under a dual grouping, such as consultant as well as manufacturer. It is common practice with judging boards to eliminate the individual if any classification under which he may be grouped is eliminated by the contest rules.

All contests require the entry to appear under some code number, never under the name of the individual. It is considered difficult to judge an entry objectively when reputation or personality of an entrant is well known. The contestant should use his assigned *entry number* and should not in any way attempt to mark his work for individual identification.

Properly conducted competitions specify the *size and other arrangement* requirements for all exhibits. These requirements have been worked out to conform to standard materials available and for rapid judging of the material in a uniform manner. Heterogeneous arrangements of data and sizes of displays may make the task of judging slow and tiring, with the result that judging becomes uninteresting and the final judgments may be approximately as haphazard as the non-uniformity of the displays.

AUTHOR: Professor of Electrical Engineering, University of Illinois, Urbana, Illinois.

Where the contest does not limit the *number of entries* by an individual, some are inclined to enter a mass of material, good, bad and indifferent, in the hopes of winning a prize. Since all entries by any one individual invariably display certain identifying characteristics, the judges soon recognize that entrant's work. There is a tendency to either limit the awards for such an individual, or sometimes not even to consider any of his entries after the first few samples, especially if by chance these might be inferior. A good plan is to do the best job possible on a single good exhibit which could be classified as superior.

That which applies to multiplicity of entries also applies to the limiting of the entry to a single good subject. One office or classroom installation which is good will receive more close attention than an exhibit composed of several offices or classrooms picturing a building as a whole. There is no doubt that a large area of competency should have greater merit than a single performance but the diversity of an exhibit, if spread too far, will detract from the interest.

Rules concerning the *actual material* which is to appear on entry and how it is to be *arranged* are things often neglected or handled in an individual manner. The conditions have been set up because it makes possible the uniform judging of all entries in the contest and neglect of these essential items is the first point to strike the minds of the judges. Neglect here means elimination before the actual merit of the exhibit has been judged.

Some of the items specified under material may be specific equipment, photometric data, customer

benefits, photographs and layouts. Read carefully the requirements in any of the categories specified and arrange your material by several trial runs before a permanent arrangement is decided upon for the assemblage.

As important as understanding and observance of the rules, which determines if the other factors are even to be considered, is the final analysis and preparation of the material for the installation which is to be submitted. The thing that sells a good installation is the *simplicity* and *clarity* with which the final lighting story is told.

Appearance is an attention-attracting factor and by appearance the entrant must hope to catch the eye of the judge in a passing instance which will hold him for an additional look. The judge does not at this time see any individual item but he takes a picture view of the entry and its smartness leads to the assumption that something is present which must have merit. This is not a matter of any one item but the composition as a whole. One of the factors influencing appearance is the photographs. They should be clear, large and not retouched. There is usually at least one member on a judging team who has experience with what is politely called doctoring of photographs. Retouching is immediately recognized and considered as an attempt on the part of the contestant to put something over. "Before and After" photographs show quickly and clearly what improvements have been made, while color photographs add another item in the attraction scheme.

Layouts of the actual installation or custom-built equipment add much to the clarity, but when such layouts are cluttered up with irrelevant data or details so as to obscure the prime merit or objective of the job, there is an unfavorable reaction. Good photographs, clear layouts and proper balance in arrangement should be given careful attention.

Data should be given if requested, for this is one of the rule requirements. Failure to recognize this point may mean elimination at the review stage of the judging. Data may be given on photographs or by tables. However, the former carries the better interpretation. Brightness readings, illumination readings, appearance of the lighted area (a study of brightness contrasts) in one composite picture, give all the information concerning the quality and quantity of lighting for the task under consideration. Many contests require a declaration of the area under which the entry is to be filed; industrial, school, office, store, etc., and others fall into a catch-all classification known as miscellaneous, a most difficult group to judge. Considering church lighting as against that of filling station or ball park lighting, for instance, is a game of chance and the entrant must recognize the odds he is taking when selecting a subject under a miscellaneous classification.

The foregoing has dealt with the material which is more or less objective. However, there is the element of subjective approach, and frequently the contestant is at a loss as to how to proceed in placing his emphasis. While there is some variation between Boards of Judges, this is not as great as the difference between individual judges in a group. The proper selection of a judging group quickly levels out the various peculiarities and tastes of the individual.

Shall the emphasis be placed upon the merits of the design or upon salesmanship, trying to approach the judge by sales tactics? The average judging group knows most of the sales tricks. There is nothing which will take the place of a superior design adapted correctly to a definite lighting requirement. Excellence in the engineering carries much more weight than an attempt to sell the judges an attractive layout which is based upon poor analysis.

Judges are impressed with subjects which show new trends or a new approach to an old story. The typical package job has lost its appeal to those who are looking for meritorious lighting installations. Even the youngest cub in the business can place rows of lights or patterns of lighting in a regular room using good equipment and develop a standard quality and quantity of lighting. This type of design is of the "cook book" type and shows no ingenuity or imagination. In recent contests consideration has been given to the cost of the installation for the benefits received and the ease with which the lighting initially installed may be maintained.

Summary

In summary it may be stated that the item of first importance is observance of the rules of the contest. Second, the appearance of the exhibit. Third, the element of imagination in the installation development. Fourth, the correct quality and quantity of lighting. Though this last is the most important factor to both the customer and the profession, it is usually the last item to be judged. Even with a superior lighting installation, its merits may not be recognized unless the entry is brought through the progressive steps to a final judgment and is not eliminated because it is defective in the first three items.

Start your exhibit early so that each item may be given its proper consideration and allotment of time, and so that the exhibit will be delivered well before the final date. If an early start is made, many mistakes in last minute rush tactics

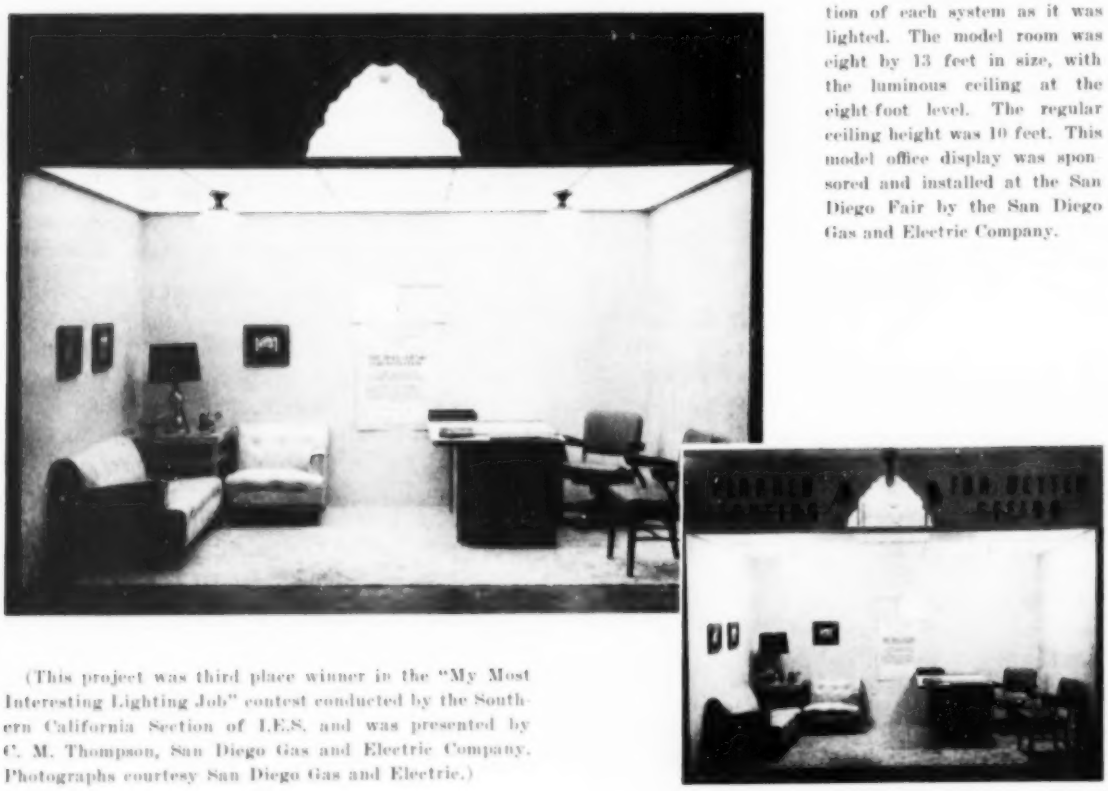
will be avoided. The quality of the entry far outweighs the quantity of material. This is true in particular for testimonials, for anyone recognizes the fact that an entry will never contain material which presents adverse criticism or anything that would be derogatory to the performance of the installation. Progressively throughout the years, contests have been lifted from a very few good lighting installations to a level where very few poor installations are submitted. This makes it doubly necessary for the contestant to have something different in the form of an imaginative development to place in the ranks of the final judging.

Model Office Demonstrates Better Lighting

Designed to demonstrate that high intensity lighting can be provided without glare, the model office shown in the illustrations below enabled 125,000 visitors to the 1952 San Diego Spring Fair of Modern Home Ideas to compare the Difference in comfort between 15 ft c of poor quality lighting and 85 ft c of high quality lighting. In this clever walk in demonstration, designed by C. M. Thompson of the San Diego Gas and Electric Company, a flasher operating on an eight second interval alternated the lighting effect of an enclosing globe system with that of a modern luminous ceiling.

The enclosing globe system consisted of two 14-inch diffusing bowls, housing 200-watt filament lamps, mounted against the luminous ceiling. This system provided approximately 15 ft c on the working plane with a maximum brightness on the globes of 1400 footlamberts. The luminous ceiling, illuminated from above by nine eight foot fluorescent strips using slimline lamps, provided 85 footcandles with a maximum brightness of only 208 footlamberts.

A cut away section permitted the public to see how the luminous ceiling was lighted, and trans illuminated panels on the rear wall of the room called the attention of the viewers to the footcandle level and the quality of the illumination of each system as it was lighted. The model room was eight by 13 feet in size, with the luminous ceiling at the eight foot level. The regular ceiling height was 10 feet. This model office display was sponsored and installed at the San Diego Fair by the San Diego Gas and Electric Company.



(This project was third place winner in the "My Most Interesting Lighting Job" contest conducted by the Southern California Section of I.E.S. and was presented by C. M. Thompson, San Diego Gas and Electric Company. Photographs courtesy San Diego Gas and Electric.)

Characteristics and Applications of High-Frequency Fluorescent Lighting

By J. H. CAMPBELL
H. E. SCHULTZ
D. D. KERSHAW

IN 1947 two technical papers on high frequency fluorescent lighting were presented. The first[1] showed the advantages of high frequency fluorescent lighting and corresponding circuits. The second[2] described a new type of frequency converter, then in the development stage. During the interim, illuminating and power engineers have maintained an active interest in the possibilities for high frequency lighting.

The recent announcement of a successful installation of 360-cycle fluorescent lighting in a special application has added considerably to the interest in this subject. It, therefore, is appropirate at this time to report new data involving both fluorescent lamps and the magnetic frequency power supply.

Lamp Efficiency vs. Frequency

The curves in Fig. 1 illustrate lamp efficiency in terms of lumens per watt within a frequency range of 60 to 20,000 cycles. All lamps were measured for relative changes in light output while lamp watts were maintained at the 60-cycle rating point. Ballast for the 60-cycle reference point is the conventional series inductive reactance, while all ballasts for higher frequencies are capacitor ballasts. Since power supply wave shapes will be discussed later it is important to note that all data for Figs. 1 to 3, inclusive, were obtained with a sine wave power supply.

In Fig. 1, the lamps of each group represent the same bulb diameter with varying lamp lengths. Each set of curves thus introduces only one variable in lamp dimension.

It will be noted that most of the curves have similar shapes, but vary in the rate of increase in efficiency with frequency. Referring to Fig. 1A, the shorter lamps of the same diameter have the greater overall efficiency increase for any given frequency compared to 60 cycles because the losses at the electrodes are a larger percentage of lamp watts. The reduction of these losses is responsible for a portion of the efficiency increase.

Lamps of the same diameter and length such as the 90-watt T-17 and 40-watt T-17 (Fig. 1B) show about the same relative increase in efficiency with differences in current density. While the lamps are of the same dimensions, electrodes are of widely different design and starting gas mixtures are of different types.

Curves for the 96-inch T-8 and 30-watt T-8 lamps (Fig. 1C) show a reduction in efficiency at 360 cycles compared to 60 cycles. This is due largely to the relatively poor current wave form with a capacitor ballast operating a T-8 lamp. Small diameter lamps require a higher voltage for re-ignition each half cycle than larger diameter lamps. With a sine wave power supply and a capacitor ballast, voltage for re-ignition is not available early in the cycle. This results in a peaked current wave form and a subsequent reduction in light efficiency. This effect can be reduced by adding a small amount of inductance to the line, increasing the frequency, or by operating the lamps on a square wave power supply, which will be discussed later in the paper.

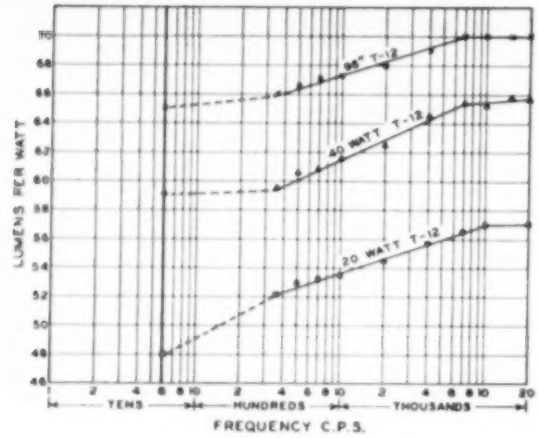
Lamp Efficiency

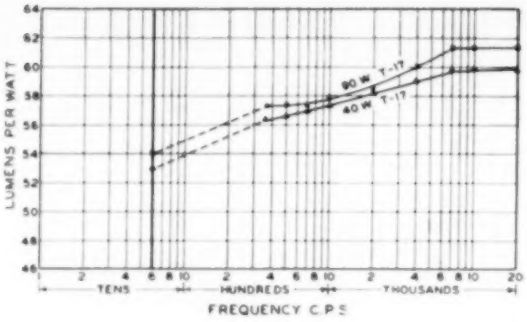
Forsythe and Adams[3] have shown the various losses in fluorescent lamp arcs and electrodes at 60 cycles. End losses for lamps alike in all respects except length are equal, and are made up of the potential drop at the cathode, the potential drop at the anode, and the IR drop across the filament portion of the electrodes.

Lamps operating at 60 cycles will have cathode drops of 10 to 15 volts, anode drops of 3 to 6 volts and electrode filament drops of 2 to 3 volts. If all the end losses of a 40-watt lamp were eliminated, the increase in lamp efficiency would be approximately 20 per cent. Referring to Fig. 1A, the 40-watt lamp shows a gradual gain in efficiency with a maximum of 12 per cent at 20,000 cycles. Lamp watts were held constant throughout the frequency range, consequently it is assumed that reduced end losses make more of the total watts available for light production. Part of this gain may also be due to increased efficiency in the production of the 2537 degree exciting radiation.

Since the purpose of this paper is to report the results of the operation of fluorescent lamps as a

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHORS: General Electric Co., Nela Park, Cleveland, Ohio.





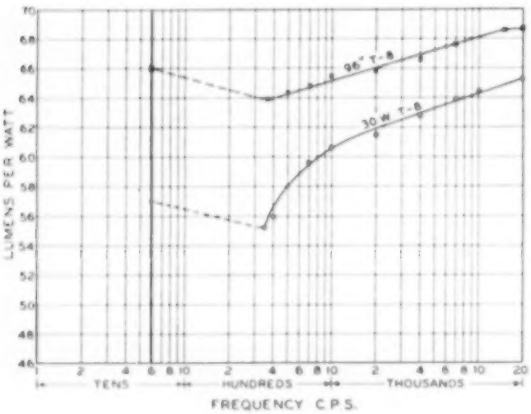


Figure 1. Lamp efficiency vs. frequency for constant lamp watts plotted in family curves according to bulb diameter. Standard Cool White lamps were used throughout the tests. A (above left) The T12 family of lamps operated at the following line voltages: 96T12 at 600v; 40-watt T12 at 400v; 20-watt at 120v. B (above) The T17 lamps: 90-watt T17 at 150v; 40-watt T17 at 400v. C (left) The T8 lamps: 96T8 at 600v; 30-watt T8 at 200v.

unit at high frequencies, no attempt was made to resolve the effect of each of the component lamp variables. A comprehensive investigation of these conditions could well be the subject of another paper.

Relative Efficiency vs. Lamp Current

The curves in Fig. 2 represent relative luminous lamp efficiency vs. lamp current at three operating frequencies. A glance at Fig. 2 emphasizes the well-known fact that lamp efficiency decreases with increase in lamp current. However, lamp current can be greater at high frequencies and still result in the same efficiency obtained at design current and 60 cycles. This is due to reduction of end losses and improvement of operating current and voltage wave shapes as frequency increases. The improvement in wave shape results in an increase in lamp power factor to near unity as frequency increases.

Fig. 2C shows the dynamic characteristics of the lamp at 60, 360 and 2,000 cycles. The curves are traced counter clockwise with voltage horizontal and current vertical. The high re-ignition voltage at 60 cycles causes the peaks on the curve at the right and left. Then as the current increases there is a lag in ionization resulting in a relatively high lamp voltage. As the current decreases there is an excess of ionization so that the lamp has a relatively lower voltage. The effect of this lagging ionization is to lower the power factor of the lamp. As the frequency is increased the degree of ionization tends to remain at the average, thus reducing the re-ignition voltage as shown by the diagrams for 360 and 2,000 cycles where the trace approaches a single line. At high frequencies the lamp is like a resistor having a high power factor.

Relative Light Output vs. Lamp Current

Referring to Fig. 3, when lamp current is increased light output will also increase. In the range of 60 cycles to 360 cycles, lamp voltage and lamp watts decrease, and therefore, the total light output curve is lower at 360 cycles even though lamp efficiency increases. At frequencies beyond 360 cycles, lamp volts gradually increase and lamp watts finally exceeded 60-cycle values at 20,000 cycles. Figs. 3A and 3B show relative lumens vs. lamp current at four frequencies. As an example of the

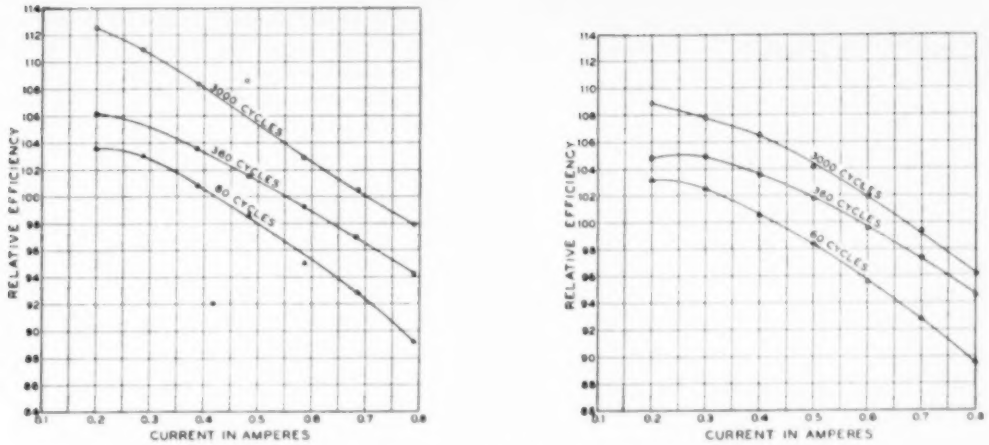
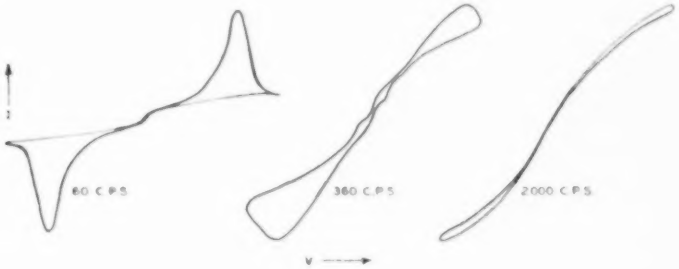


Figure 2. Relative efficiency vs. lamp current for 60, 360 and 3,000 cycles per second. A (left) 40-watt T12 lamp. B (right) 96T12 lamp.

C (right) Dynamic characteristics at 60, 360 and 2,000 cycles.



possible increase in lamp lumens (Fig. 3A), the light output increase at 20,000 cycles for 600 ma is 40 per cent compared to the 60-cycle rating of 425 ma and 57 per cent for a current density of 800 ma. The increase in light output for the same current values at 60 cycles is 24 per cent and 38 per cent respectively. The application of these data as it pertains to operation of fluorescent lamps at higher current densities will be influenced by other factors which have not been fully determined. Such factors are lamp life, lumen maintenance and ambient temperatures.

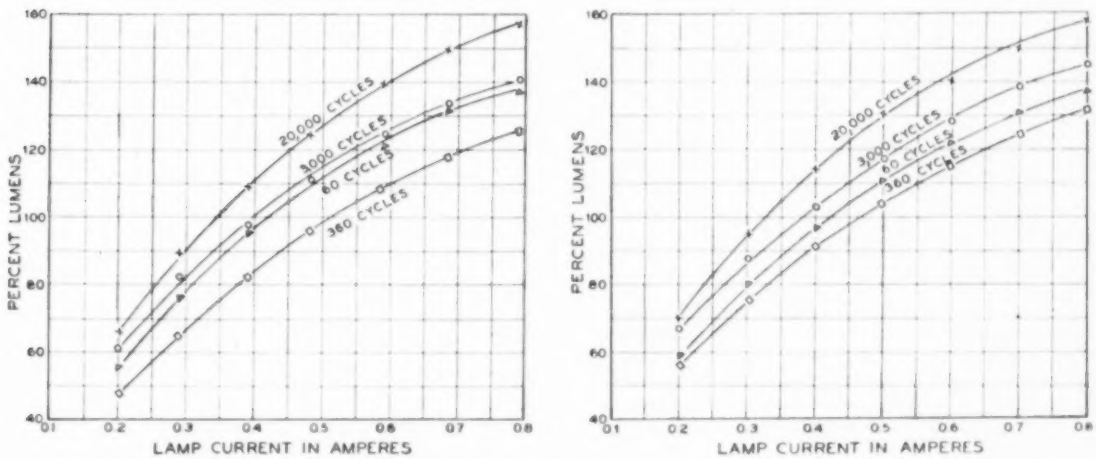


Figure 3. Relative lumen output vs. lamp current for four frequencies. The output is given in per cent of the rated output on 60 cycles. A (left) 40-watt T12 lamp. B (right) 96T12 lamp.

Square Wave Operation

All previous data reported has involved the conventional sine wave form as developed by rotating a.c. machinery. Since the development of the magnetic frequency converter, the authors have tested various lamps on a square wave form of current to correspond with the load characteristics of this equipment.

In order to show typical lamp characteristics, a 40-watt lamp was operated with a 360-cycle square wave current supplied by laboratory equipment. The wave forms used had a peak to R.M.S. value of 1.10 to 1.14.

Fig. 4A shows that square current waves at 360 cycles produce lamp efficiencies considerably greater than sine waves at either 60 or 360 cycles. In fact the efficiency at rated lamp current is equivalent to 20,000-cycle sine wave operation.

With square wave operation there is no deionization time between half cycles and at the higher frequency the cathode does not cool between re-ignition points. End losses are reduced and possibly the efficiency of exciting radiation is increased at a lower power frequency compared to sine wave operation.

Fig. 4B shows a marked increase in total light output for square wave operation. Here again the effect is the same as an increase to about 20,000-cycle sine wave operation. The increase in lamp lumens with a 360-cycle square wave compared to a sine wave of the same frequency is due to an increase in lamp voltage and lamp watts resulting from the square current wave shape.

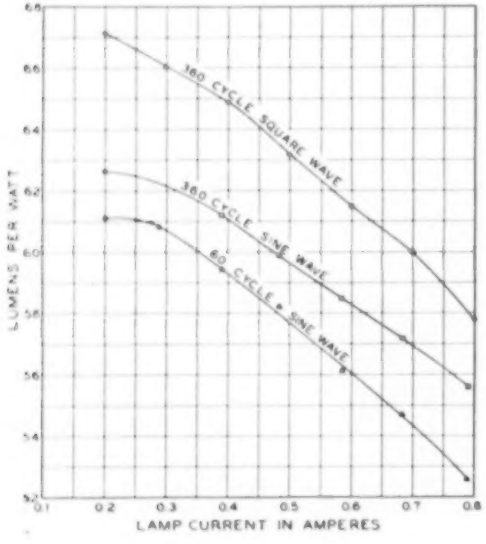
Fig. 4C shows this comparison for 360 cycles with lamp current ranging from 200 to 800 ma.

Ballast Determination

The curves of Fig. 5 show ballast ratings in microfarads and also in henries for each lamp tested over the entire frequency range for a sine wave power supply. Each ballast shown would deliver rated lamp watts. If half the lamps of any load have capacitor ballasts and the remaining half inductive ballasts, the line power factor will be close to unity.

Overall Efficiency

A conventional series inductive reactance ballast has been used in each case to obtain the 60-cycle base figures for comparison of lamp characteristics.



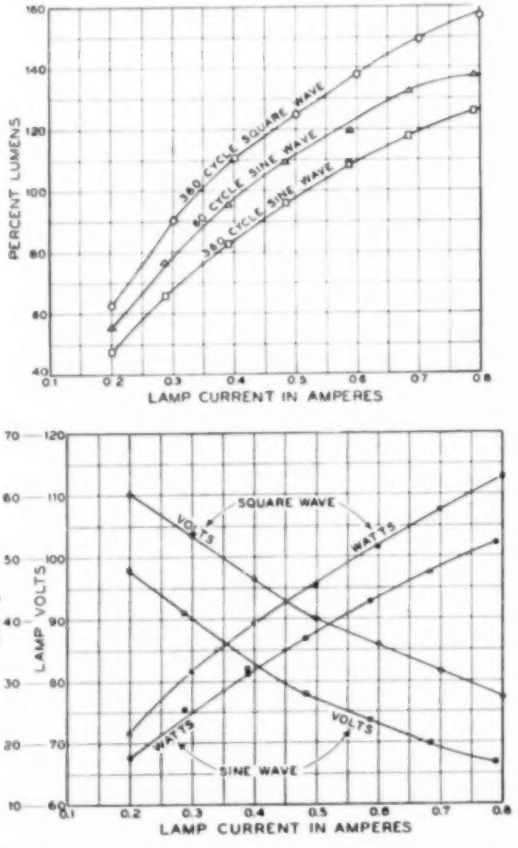


Figure 4. Square current wave and sine wave 40-watt T12 lamp characteristics. A (above) Lamp efficiency vs. lamp current. B (above right) Relative lumen output vs. lamp current. C (right) 360-cycle sine wave and square current wave lamp voltage and watts vs. R.M.S. lamp current.

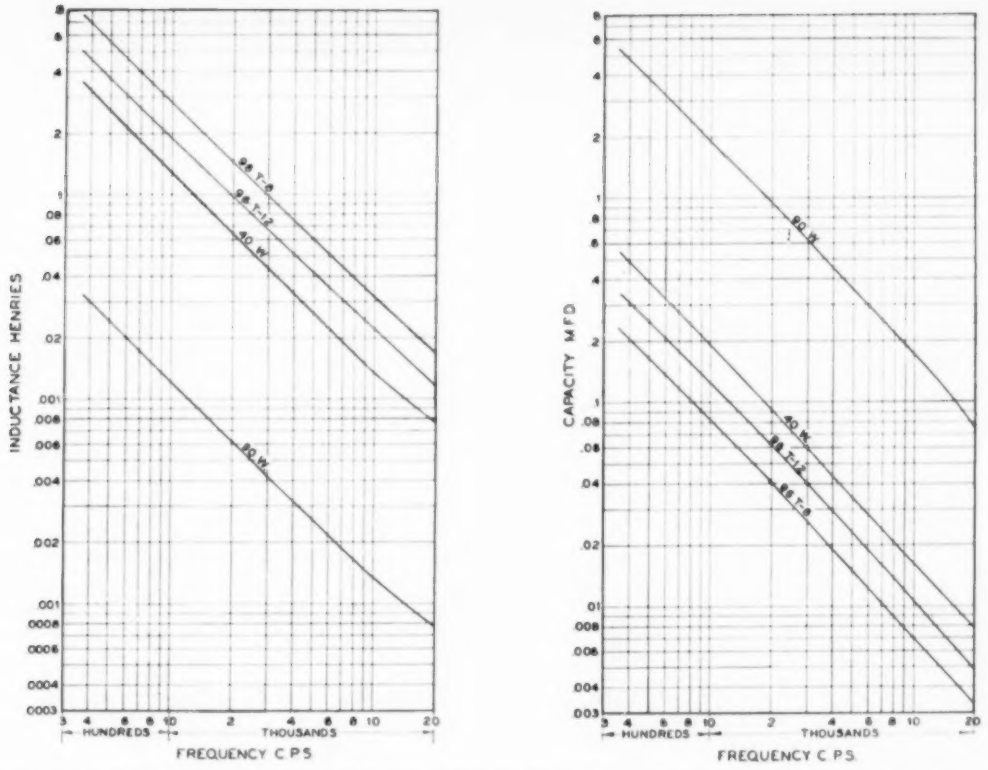


Figure 5. Curves of inductive and capacitive ballast values for various lamps vs. frequency. The line voltage for each of the lamps is as follows: 96T8 and 96T12, 600v; 40-watt T12, 400v; 90-watt T17, 150v.

All lamp characteristics for higher frequencies have been obtained by means of a capacitor ballast. The equivalent inductive reactance produces essentially the same lamp characteristics at most frequencies because of the similarity in current wave shape. T-8 lamps are an exception at the lower frequencies due to the poor waveshape on a capacitor ballast.

Table I gives an overall relative circuit efficiency comparison between 60 and 360 cycles. For each lamp, the highest and lowest loss instant start 60-cycle ballast has been chosen and the overall efficiency taken as 100 per cent. This gives a range of overall efficiency gain derived from 360-cycle operation. The values for 360 cycles show the total efficiency compared to 60 cycles including lamp and ballast efficiency. Inductive reactor type ballasts are not shown in this table because specific ballasts have not been designed for each lamp at 360 cycles. It is expected that inductance losses will be somewhat higher and consequently gains in overall efficiency would be slightly lower than shown in Table I. These data provide a means for determining the required converter efficiency to equal or better the 60-cycle overall efficiency.

Lamp Life

A 400-cycle sine wave life test was conducted on 40-watt lamps. The test covered three ballast circuits, each of which was adjusted for rated lamp current. A second set of the three circuits were adjusted for rated lamp watts. The tests were run concurrently with conventional 60-cycle ballasts. The lamps operated on a capacitor ballast at 400 cycles with a starting switch and no compensator gave less life than those on conventional 60-cycle ballasts with compensators.

Since it is anticipated that use of high frequencies will follow the instant start trend, more interest centered around the results of instant start circuits. A capacitor ballast at 400 cycles comprising part of a resonant start circuit gave greater

TABLE I.—Comparative Overall Circuit Efficiency

Lamp	60 Cycle Overall Efficiency in Per Cent	360 Cycle Ballast	360 Cycle Overall Efficiency in Per Cent
90WT17	100	Capacitor 150v.	115-125
96T12	100	Capacitor 600v.	120-125
40WT12	100	Capacitor 400v.	124-131
96T8	100	Capacitor 600v.	128

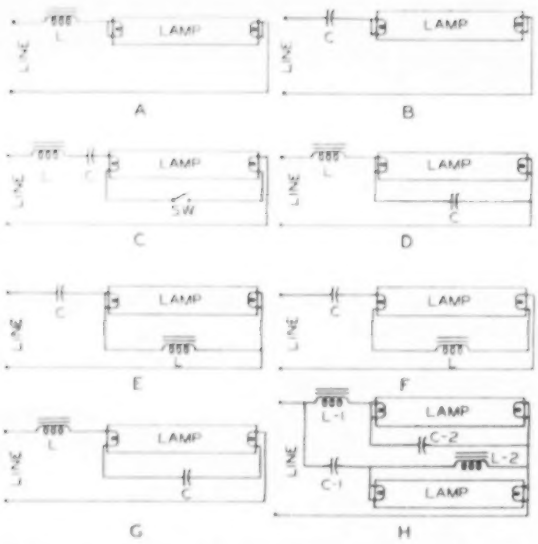


Figure 6. Circuits for operating fluorescent lamps at high frequency. Circuits A and B require distribution of the starting voltage of the lamps. Circuits C through H will require distribution of a voltage sufficient to regulate the lamp. The lamps are started by the high voltage generated by the resonant circuits.

lamp life than the 60-cycle instant start control test. The companion circuit using a choke type ballast at 400 cycles showed a still greater increase in lamp life.

Many more life tests and results of field experience will have to be obtained before definite life figures can be established. Life test results have not been obtained as yet for square current waves, but it is anticipated that lamp life will be at least as favorable as on sine waves.

Circuits

For the purpose of obtaining lamp characteristics, the lamp starting voltage was distributed to the lamps and the simple circuits shown in Figs. 6A and 6B were employed. In many installations where proper protection can be obtained, these two circuits would have the advantage of high voltage distribution and the lightest weight ballasts. However, many other circuits were tested as shown in Figs. 6C to 6H. Circuits such as these can be designed to provide the starting voltage by means of resonance, so distributed voltage need be only that required for proper current regulation. In some instances converter size could be reduced and efficiency increased, if the distributed voltage is held to the minimum. A resonant circuit for 360 cycles would be about 1/5 the size and weight of the 60-cycle equivalent. At 3,000 cycles and above, a ballast of this type becomes miniature in size, comparing favorably with the physical dimensions of a 60-cycle starter.

Applications

All applications of high frequency fluorescent lighting to date have been confined to installations of a more or less special nature. Applications[4] now in use include airplane and motor coach lighting, where either 400-cycle or variable frequency rotary power supplies are available.

Rotary converters can be obtained in a wide variety of sizes and frequencies. Most rotary equipment cannot be operated successfully on a low leading power factor such as would be the case with a fluorescent load made up exclusively of capacitor ballasts. However, the ballasts can be designed to operate each pair of lamps on a split-phase ballast consisting of one inductive reactance and one capacitive reactance, thus producing a high lagging power factor.

Electronic converters have not been applied extensively in fluorescent lighting. Relative high efficiency can be obtained by this means. The development may offer another equipment with the advantage of low maintenance.

The most recent application of high frequency fluorescent lighting involves the use of a magnetic frequency converter without moving parts. This installation is located at the United States Department of Agriculture, Plant Industry Station, Beltsville, Maryland. High frequency operation of fluorescent lamps was particularly well adapted to this installation where experiments in plant growth with artificial lighting are carried on. The eighty-eight 96-inch T-8 slimline lamps in the growth room are located 1 inch apart. Here the light-weight low-loss capacitor ballasts can be located at the lamps with the frequency converter in the transformer vault. Only two power lines are required to bring the 360-cycle, square current wave power to the lamps. Previous growth rooms had used 60-cycle ballasts which had to be located remotely and 90 wires were needed to carry power to the lamps.

The Magnetic Frequency Converter

As a method for converting 60 cycles to 360 cycles, the magnetic frequency converter, now in the early stages of design, has several advantages and limitations as follows:

Converter Advantages

1. Low maintenance.—Since there are no moving parts the device should be nearly as maintenance free as a transformer.
2. Produces square current wave.—Lamp advantages as described in Fig. 4.
3. Output current can be regulated. — Simple control at panel can be used to increase or decrease current to lamp load.

4. Converter can be located in transformer vault.
5. High efficiency (approximately 75%).

Converter Limitations

1. The present installation requires 3-phase power input.—Probably a disadvantage in outlying districts or small installations. Single phase converter can be designed.
2. Total weight.—Present converter has weight somewhat greater than 60-cycle ballasts for the same load.
3. Supplies constant current.—Groups of fixtures on the same circuit cannot be turned off without increasing lamp current in remaining fixtures. This characteristic would probably not be a disadvantage in industrial lighting, but would be a definite limitation for lighting groups of small offices.
4. Higher initial cost.—At this writing the converter cost estimate is considerably greater than 60-cycle ballasts for the same load.

360-Cycle System Advantages

When the advantages of the magnetic frequency converter are coupled with the previously reported fluorescent lamp gains, we have the following 360-cycle system characteristics:

1. Lighter weight fixtures.—Fixtures can be considerably lighter than with the 60-cycle system because of the use of ballasts weighing only a few ounces.
2. Considerably less heat loss at the fixtures.—With some slimline lamps the reduction in ballast loss amounts to 85 per cent or more. In large installations there would be considerably less load on the air-conditioning system.
3. More lumen output per lamp.—In some installations it will be desirable to increase the lumen output of each lamp. The square current wave form developed by the magnetic frequency converter is a large factor in obtaining the increased light output.
4. Lumen output can be regulated.—Lamp current can be increased or decreased by means of a simple control at the converter panel. This suggests a convenient way to make up for the depreciation in lamps and fixtures by merely adjusting each converter as the depreciation takes place. This would eliminate the need for cleaning fixtures until the lamps can be replaced as a group. After cleaning and relamping, the system could then be adjusted to normal lamp current and the cycle repeated.

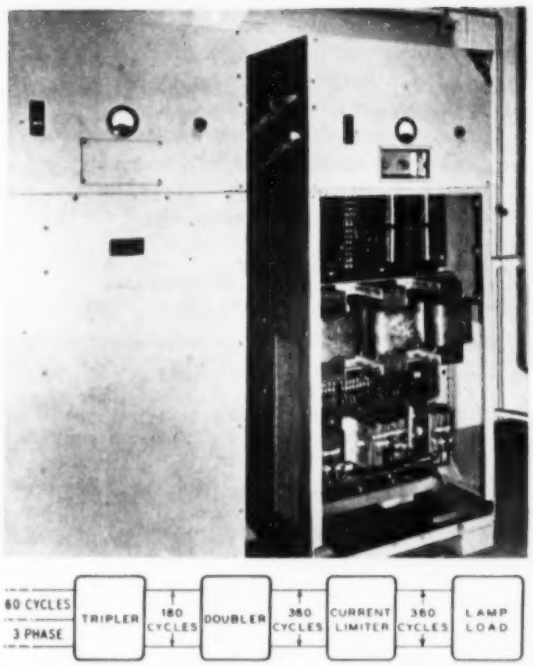


Figure 7. The two magnetic frequency converters in use at the Department of Agriculture's Beltsville project for supplying 360-cycle current to an installation of 88 96T8 lamps. The lower drawing is a block diagram of the frequency converter.

5. Silent operation.—In many installations such as libraries, television and radio studios it is sometimes necessary to place 60-cycle ballasts in a remote position from the lighting installation in order to avoid hum. This requires at least one wire per lamp plus a common to deliver power to the fixtures. In the 360-cycle system the capacitor is silent during operation and the converter can be placed in the transformer vault where noise and heat dissipation are relatively unimportant. Only two wires are needed to deliver power to the lighting installation.
6. Reduced stroboscopic effect.—With a square current wave at 360 cycles the decrease in light output each half cycle is so low, it is difficult to measure.

Summary

This paper has been written to provide the industry with the present status of high frequency operation of fluorescent lamps and to comply with many requests for information on which to base an analysis for possible applications. While most all of the characteristics of high frequency lighting are desirable for general applications, the econom-

ies of frequency conversion must be improved to justify widespread use. Meanwhile in some special applications the system desirability is sufficient to warrant applications now.

In the opinion of the authors sufficient progress has been made since the last report to improve the status of high frequency lighting from one of possibility to one of strong probability.

References

1. Campbell, J. H. "High Frequency Operation of Fluorescent Lamps." ILLUMINATING ENGINEERING, Vol. XLIII, No. 2, p. 125 (February 1948).

2. Campbell, J. H., and Bedford, B. D. "Fluorescent Lamp Operation at Frequencies Above 60 Cycles." *Proceedings of the National Electronics Conference*, Vol. 3, p. 307 (1947).

3. Forsythe and Adams, "Fluorescent and Other Gaseous Discharge Lamps," Murray Hill Books, Inc., ch. 4, p. 81.

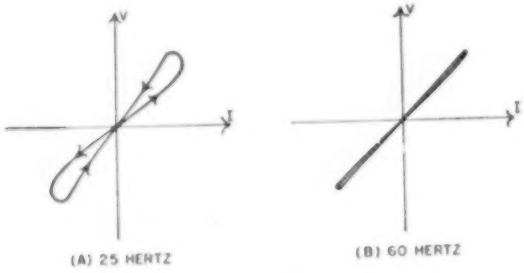
4. Campbell, J. H. "Special Circuits for Fluorescent Lamps." ILLUMINATING ENGINEERING, Vol. XLV, No. 4, p. 235 (April 1950).

DISCUSSION

DOMINA EBERLE SPENCER*: The authors are to be congratulated on the presentation of what is, perhaps, the most significant paper at this 1952 Conference. My comments will not be a criticism of the paper, but will be supplementary to it.

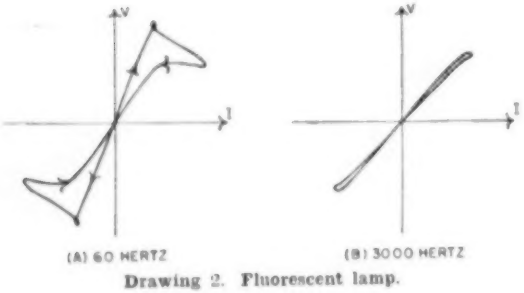
Following the English author, Francis,[1] I should like to point out an analogy between incandescent and fluorescent lamps. The dynamic volt-ampere characteristic of an incandescent lamp depends on the instantaneous temperature of the filament and on its thermal history. At low frequencies, say 25 hertz (1 hertz = 1 cycle per second. The hertz is the mks unit of frequency), the filament cools off during the cycle and the resistance of the lamp is not constant. The result is that the volt-ampere characteristic has the looped shape shown in Drawing 1a.

*University of Connecticut, Storrs, Conn.



(A) 25 HERTZ (B) 60 HERTZ

Drawing 1. Incandescent lamp.



(A) 60 HERTZ (B) 3000 HERTZ

Drawing 2. Fluorescent lamp.

At higher frequencies the current varies so fast that there is not sufficient time for the lamp filament to cool appreciably during one cycle. The resistance is essentially constant and the volt-ampere characteristic becomes a straight line as in Drawing 1b. Thermal equilibrium of an incandescent lamp filament is attained at 60 hertz. Therefore, this is an entirely satisfactory frequency for the operation of incandescent lamps.

The case is somewhat different for fluorescent lamps. The volt-ampere characteristic of a fluorescent lamp depends primarily on the state of ionization in the electric discharge. At 60 cycles there is time for the column of gas to almost completely de-ionize. As the frequency is raised the discharge goes into a state of dynamic equilibrium in which the state of ionization is essentially constant. The difference is that with the fluorescent lamp, equilibrium of the discharge column is not obtained at 60 but at 3000 hertz (Fig. 2 of the paper). Thus the frequencies which were entirely suitable for incandescent lamps are not those best fitted for fluorescent lighting. The difference occurs merely because the time constant for de-ionization of the fluorescent lamp discharge is much less than the time constant for thermal cooling of the incandescent lamp filament.

By similar reasoning we are led to expect a square wave to be superior to a sinusoidal wave as thermal or ionization equilibrium will be attained at lower frequencies.

If I had sufficient time, I would like to go much further than Campbell, Schultz and Kershaw have in making a strong case for using high-frequency fluorescent lighting today. It is time the illuminating engineer learned to design electric circuits tailored for the fluorescent lamp, just as he has learned to design fluorescent luminaires by new methods not required in the days when incandescent lighting was the only possibility for most applications. I think that there is a strong case for introduction of the high-frequency fluorescent on a purely economic basis, if the problem is thoroughly analyzed.

Moreover, this change to high frequencies is in the direction of the recommendations of the widely publicized report[2] of the President's Materials Policy Commission. This report has emphasized the need for conservation of the nation's raw materials. It showed that, while the per capita "consumption" of metals nearly tripled between 1900 and 1950, the per cent of our metal requirements which were imported increased from only 1 per cent in 1900 to 43 per cent in 1950. For non ferrous metals only, this change was even more striking. In this case, we *exported* 12 per cent of our production in 1900, whereas we *imported* 54 per cent of our non ferrous metal requirements in 1950. Any technological development which will make possible savings of metal requirements is important to the national economy today.

My experience indicates that substantial savings in the weight of metal required for fluorescent lamp auxiliaries can be made by using high frequencies. I hope that subsequent Conferences will include further papers on high frequency and square wave lighting.

1. Francis, V. J.: *Fundamentals of Discharge Tube Circuits*, John Wiley & Sons, New York, 1958, Chapter III.

2. *Resources for Freedom*, A Report to the President by the President's Materials Policy Commission, June 1952. United States Government Printing Office, Washington, D. C. Data from Vol. II, The Outlook for Key Commodities, Chapter 24, Production and Consumption Measures by Vivian Eberle Spencer and C. A. R. Wardwell.

E. W. Beggs*: Mr. Campbell has been carrying the torch on high frequency operation of fluorescent lamps for several years and is making progress. May he continue his researches in this interesting field.

I did some testing on lamps and circuits during the war for low temperature airplane lighting and found good operating characteristics in cold air as well as at normal temperatures, as he described. Actually, the 400-cycle power is now widely used on military airplanes to operate the controls and to provide the lighting, and its use is increasing there and elsewhere.

High frequency a-c is particularly well suited to buses, airplanes, ships and railway cars where we do not have standard frequency a-c power available. It not only increases overall efficiency somewhat but it also reduces the size and weight of the equipment, which is more important in transport than elsewhere. The I.E.S. Committee on the Lighting of Public Conveyances is studying this application now and hopes to have progress to report next year. It is quite probable that the first extensive use of high frequency will be in transportation lighting.

G. C. Harvey**: Many people have asked how soon ballast manufacturers will be out of business.

This is a logical question, for surely there are many advantages to the system as outlined by the authors.

Progress in the art of ballasting the fluorescent lamp has been rapid, but at the present the answer to this question must be indefinite. I can say I feel sure the conventional system will be popular for quite awhile.

But certainly, our code provides that we will do our best to furnish better light at lower cost to the light user. For this reason, effort is being placed on this system and no doubt improvement in costs will be made. At the same time, the development effort being expended on the conventional system will also yield additional benefits.

*Westinghouse Electric Corp., Lamp Division, Bloomfield, N. J.
**General Electric Co., Specialty Transformer and Ballast Department, Fort Wayne, Indiana.

J. H. Campbell, H. E. Schultz, D. D. Kershaw*: Dr. Spencer's comments and supplementary information are of considerable value to the project of high frequency lighting. It is gratifying to the authors to receive a discussion showing a progressive interest in the overall value of this new system and a good technical appraisal as well.

If there had been a choice between 60 cycles and higher frequencies at the time fluorescent lamps were first announced there is no question that higher frequencies would have received first consideration.

Many improvements have been accomplished in circuit and ballast design for 60-cycle power over a period of thirteen years. If frequency converters can be produced at a cost approaching that of 60-cycle ballasts, the gain in all phases of fluorescent lighting would make previous improvements seem small by comparison. This is a challenge to electrical engineers which we are certain will not be overlooked. Meanwhile, some specific fields of lighting have adopted high frequency power, and many others are planning installations for 360-cycle square wave power.

While tests to determine characteristics of fluorescent lamps operating at high frequencies have been rather comprehensive, more work needs to be done to specify optimum conditions for the many types of lighting installations where it is is desired to use high frequency.

I agree with Dr. Spencer that further studies should be made concerning relative economics and critical materials. Data should include proposed new methods of frequency conversion as well as presently available equipment.

The authors wish to thank Mr. Beggs for his generous comments regarding the future of high frequency lighting.

Mr. Beggs has said that there may be extensive use of high frequency for lighting in the transportation field. Already he mentions many airplanes[4] are so lighted. In the motor coach field[5] there are now about a thousand buses lighted with slimline lamps on a variable frequency power supply (100 to 600 cycles). High frequency lighting may also be extended to subway and railway coaches.

*Authors.

New Industrial Lighting Standard

A new American Standard Practice for Industrial Lighting, long-awaited and now with full approval of A.S.A. committees, is now available in 40-page booklet form through I.E.S. Publications Office. While the proposed new practice appeared in Illuminating Engineering some time ago, the new booklet includes all subsequent revisions and is the "last word" for lighting engineers and specialists; architects; consultants, contractors and others requiring detailed information for industrial lighting in all aspects. Single copies are 50c; quantity prices on request.

Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of G. S. Evans, has prepared this listing of answers to frequently asked questions. Readers are invited by the Committee to submit similar questions of general interest on light sources, to be considered for publication from time to time. Questions may be sent in care of Society Headquarters.

When sodium lamps are turned on, the color is first red, then gradually changes to yellow. What causes this?

The sodium lamp contains some neon gas and a small quantity of sodium. When the lamp is first turned on, the density of sodium vapor is very low, so that the initial discharge is through the neon gas, producing the red color characteristic of neon. As the temperature rises the sodium evaporates and gradually the sodium vapor discharge comes up to its full brightness and normal yellow color. This warm-up requires about thirty minutes.

See page 8-33, *I.E.S. Lighting Handbook*, Second Edition.

What is the effect of ambient temperature on light output of mercury lamps?

The light output of the double-bulb type of mercury lamp is little affected by the ambient temperature. For example, experience with the A-H1 has shown that this type is satisfactory for temperatures down to —20F. Single bulb types such as the A-H9 type are critically affected by low temperatures, particularly if the surrounding air is moving. Special protection is generally required for single bulb types when the ambient temperature is below 32F.

See page 8-31, *I.E.S. Lighting Handbook*, Second Edition.

Why are "fuse leads" used in incandescent filament lamps?

Fuse leads are used in most gas-filled general service incandescent filament lamps to open the lamp circuit before the arc caused by filament failure can reach destructive proportions.

Is the output of the "black light" (360 BL) type of fluorescent lamp affected by low ambient temperature the same as the types of fluorescent lamps used for ordinary lighting purposes?

These types of fluorescent lamps differ only in the kind of phosphor applied to the inner surface of the bulb. Since the lamps are otherwise similar in design and construction, they are equally affected by low ambient temperature.

Why are coiled coil filaments more efficient than single coil filaments in gas-filled incandescent filament lamps?

The primary reason is reduction in loss of energy to the fill gas. Incandescent filaments in gas-filled lamps are surrounded by a relatively stationary sheath of gas. By using coiled coil construction, the filament for a given lamp is made more compact and the gas sheath is smaller in volume, thereby reducing the loss of heat to the surrounding gas. Also, in certain types of lamps the coiled coil filament structure minimizes the number of filament supports required and thus reduces the cooling effect of the supports.

See page 8-12, *I.E.S. Lighting Handbook*, Second Edition.

What makes an incandescent filament lamp break or shatter when it is not struck by some object?

Like any glass object, a lamp may break or shatter when subjected to conditions which induce a highly localized strain. Thermal strain may occur if the hot bulb of an operating lamp comes in contact with rain, flying insects, a damp cloth, or a cool metal object. Hard glass lamps are less subject to this type of failure. Strain may also be induced by long porcelain sockets scratching the neck of the bulb.

Lighting Progress In 1951-1952

Prepared by the Committee on Progress of the Illuminating Engineering Society

IN LIGHTING there's *always* something new — whether it's a fixture, a light source, a technique, or an idea that can be employed in the infinite variety of applications through which lighting serves the public. That sentence was in an I.E.S. advertisement in the June 1952 issue of ILLUMINATING ENGINEERING. At just about the same time that the sentence appeared in print, the Committee on Progress was holding its annual session to answer that question — What's New?

Invariably when the question is first asked the immediate answer is "not much" — then as the record unfolds, we find that each year's attainments in the art and practice of illumination add to the March of Progress. Instead of too little to report there accumulates too much and the process of selection becomes arduous. This year is no different — there is much to talk about and after the record is completed and another year has gone, we can repeat the story for a new year. Then we can look back and better evaluate what now seems significant.

COMMITTEE ON PROGRESS
Theodore C. Sargent, *Chairman*
Hugh F. Carroll, *Vice-Chairman*

A. C. Barr	B. F. Greene
E. W. Beggs	A. P. Larson
O. P. Cleaver	J. A. Meacham
J. L. Cox	J. W. Steiner
Kurt Franck	G. J. Taylor

A. S. Tylor

Light Sources and Circuits

Progress in light sources for this year has yielded some new filament lamp types and a number of very significant advances in fluorescent and mercury lamp development.

Filament Lamps

The line of reflector lamps has been expanded by the addition of a 500-watt R40 reflector spot made of heat-resistant glass. The new lamp fills a long-felt need in gasoline service station lighting and other outdoor applications where its higher wattage and spot-type distribution combine to reduce the number of lamps needed to deliver desired lighting levels. The lamp serves best when burned within 45° of base-up. When used outdoors it should be installed in equipment that protects the upper part of the bulb from moisture.

Another new development is the 300-watt PAR56 flood lamp. This is a companion to the PAR 56 spot announced two years ago. A specially designed lens yields a rectangular beam pattern of about 20 by 35 degrees with a very sharp cutoff. Beam candlepower in the central 10° zone is approximately 25,000. This makes it particularly suitable for floodlighting from the greater distances involved in many of the new large service stations. It will also find usefulness in building floodlighting, sign lighting, sports field lighting, and in many other applications.

There is an addition to the line of highly efficient white filament lamps using the fumed silica coating inside the bulb. The new size is a 60-watt A19 bulb lamp. The semi-decorative 50-watt GA25 lamp has proven so popular that two more sizes have been added — the 100GA in a GA30 bulb and the 150GA in a GA40 bulb. The larger sizes are finding use in those places where a 50GA does not produce the desired amount of illumination — single socket bedroom luminaires, for example.

A group of improved 150-watt R40 color spot and color flood lamps are now available which incorporate a permanent, transparent bowl coating thus making it possible to provide a narrow or wide beam distribution pattern comparable to the standard R40 types. These lamps, following the general industry trend for all incandescent reflector lamps, carry a 2000-hour design life rating.

The longer life rating for reflector lamps, particularly in commercial and industrial applications, serves to reduce replacement costs, maintenance problems are simplified and there obviously is far less interference with the normal work activity.

A V-beam traffic lamp has been announced which has a more concentrated filament shape, having a V-section located at the focal point. The purpose is to produce a more intense spot in the beam center and more candlepower below the horizontal. This new filament shape and a 4000-hour life rating are designed to make such special purpose traffic lamps more useful as traffic safety aids.

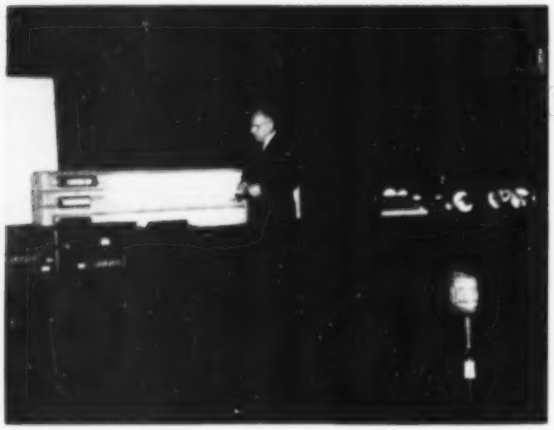
Mercury Lamps

In mercury lamps, new reflector types were introduced. They are the logical outgrowth of two other developments: the R52 or R57 filament reflector lamp, and the all-quartz small-diameter mercury tube design first introduced in the 400-watt E-H1. The new lamps combine the convenience and excellent maintenance characteristics of the reflectorized design with the high efficiency of modern mercury lamps. Two of the new types are made with R57 bulbs but are not color corrected — the L-H1 has a medium beam distribution, and the K-H1 is modified sufficiently to give a wide beam distribution.

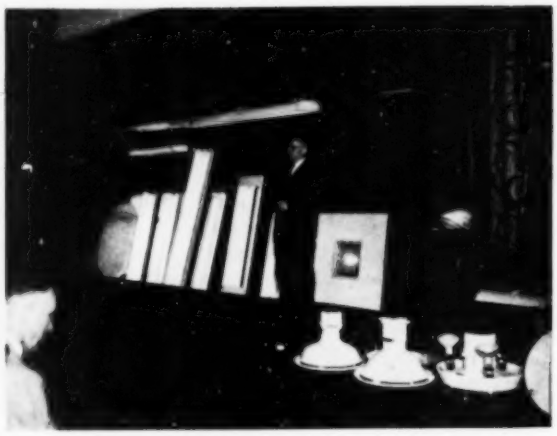
The R52 type of reflector mercury lamp may be obtained in either straight-mercury or color-improved form, the R1 and RC1. Their lighting performance is similar to that of earlier 400-watt mercury lamps used in deep-bowl luminaires. It is recommended that all reflectorized lamps be used in equipments that provide additional shielding while protecting the upper part of the bulb from moisture. The color improvement is obtained by a novel application of a red-emitting

A report presented at the National Technical Conference of the Illuminating Engineering Society, Chicago, Illinois, September 8-12, 1952. Approved by the Council Executive Committee of the I.E.S., January 9, 1953.

At the National Technical Conference in Chicago



Part of Light Source exhibit in the Chicago Progress Report presentation.



Group of industrial and commercial luminaires in Chicago Report. Navy units on table in the foreground.

Newer types of portable and residential units including television frame or border lighting.

Final tableau contrasting 1852 versus 1952 room lighting — a contribution to Centennial of Engineering celebration.

phosphor. It is coated on the internal reflector surface rather than to the light-emitting end of the bulb. This is said to increase lamp efficiency and reduce glare without any sacrifice in color improvement.

The past year has also seen the application of the color-correcting fluorescent coating to 1000-watt mercury lamps. Two manufacturers have listed this type under the designations of H-H15 and H1000-A15C. In both cases the arc tubes are similar to the previously reported A-15 type rather than the A-12 type. The A-15 arc tube is the higher voltage, lower current model of the two designs.

There is also progress to report in photochemical mercury lamps. Two new ones, the UA-15 and UA-14, are radically new in design. Both are 52½ inches long and use all-quartz bulbs of T4 (half-inch) diameter. These small diameter bulbs allow better control of light output and the use of quartz, rather than special glasses, affords very high efficiency. The UA-15 is a 3000-watt lamp, while the similar UA-14 operates at 1400 watts. Their life rating is 1000 hours and they are specially treated to reduce the generation of ozone. The lamps were developed for use in new models of B & W (Black and White) copy reproduction machines, the UA-14 for the medium speed type and the UA-15 for the high speed type. A different lamp, the UA-11, has been designed for the 16-inch wide "office" machine. This lamp is a 1200-watt design using a T6 quartz tube 21⅞ inches long. The tube is enclosed in a 1¼-inch glass bulb having high transmission in the 3100-4500-A range.

Fluorescent Lamps and Circuits

Among fluorescent lamps, the trend toward the use of slimline continues to be notable. One recent study[1] indicates that the use of slimline in new installations now exceeds the use of 40-watt preheat lamps when evaluated on an equal lumen basis. Increases in slimline life during the past year undoubtedly have had effect on the broadening use. Manufacturers now publish the same life rating for both the popu-

lar T12 slimline sizes, 48T12 and 96T12, and the standard sizes of pre-heat lamps.

Colors of fluorescent lamps appear to be generally standardized throughout the industry, with special names appearing occasionally for individual purposes. A Deluxe Daylight (5500K) is now available from one manufacturer for those applications where daylight color is preferred but the better color rendition of deluxe type lamps is desired.

Other fluorescent lamp developments center around the introduction of new circuits and methods of operation. The ballast design parameters for series-sequence ballast, which were reported at last year's conference,[2] have now been accepted as a basis for industry standards. As a result, new specifications for the certification of series-sequence ballasts were established as of December 1, 1951. Slimline lamps operated on ballasts meeting the new specification can accordingly be expected to deliver rated life performance when installed in places where the ambient temperature is not below 50F.

New Ballasts

Ballast developments of the past year include a constant wattage transformer for operating 100-watt mercury lamps, smaller and lighter instant start lead-lag ballasts for operating T12 slimlines and other instant start fluorescent lamps, and rapid start ballasts employing the constant wattage feature.

The constant wattage mercury lamp transformer has some unique advantages. It provides high starting voltage even under low line voltage conditions, and provides practically constant light output over a wide range of primary voltages. These features eliminate the need for voltage taps on the primary and assure continuous operation of the lamp under very low primary voltage conditions. This assures continued lamp operation even though severe voltage drop conditions occur. Since mercury lamps take five to seven minutes to restart, it is a matter of some importance in many industrial applications. In addition, the design eliminates the high instantaneous inrush current normally experienced when lamps are first turned on, and the ballasts are so constructed that the same model can be used on either 115-volt or 230-volt primary by appropriately connecting the two coils of the primary winding.

The new smaller lead-lag ballast is similar to the series-sequence type in size, cost and efficiency, in a design having all the valuable characteristics of the larger lead-lag types. Among the advantages claimed are:

1. Completely independent lamp operation.
2. Fast lamp starting.
3. Low peak to rms current ratio.
4. Stroboscopic correction.
5. Small size and light weight.
6. Low wattage loss.

The new ballast uses a "split-secondary" type of winding permitting design improvements and meets all the requirements set forth in the specifications of the A.S.A. and C.B.M.

The constant-wattage rapid start ballast, like the mercury lamp ballast described above, provides constant light output over a wide range of line voltage conditions. It accomplishes this in addition to meeting other ballast requirements for satisfactory operation of rapid start lamps.

The new rapid start fluorescent lamp circuit announced this year has required the introduction of a new lamp — the 40-watt rapid start bipin T12 fluorescent lamp. This new lamp-circuit combination is aimed at a development objective of long standing. It is intended to provide fast, positive starting without the use of starters, with little or no increase in initial or operating costs over those of the 40-watt pre-heat system. The method is providing the lamp with special low-voltage cathodes that are kept constantly heated at a low level by means of special cathode heating windings in the ballasts. Two rapid start lamps operate in series on a rapid start ballast having an open-circuit voltage of less than 300 volts instead of 450 volts or more, as required for instant starting. In operation, the lamps light at a low value of light output as soon as switched on. When the cathodes heat up, the lamps come up to full brightness.

Circuits involving constant filament heating have been in use in England and Europe for several years but they are new in American practice, particularly when applied to our normal 118-volt lines. Recent improvements in water-repellent bulb coatings, filament construction and manufacturing techniques have encouraged the introduction of the rapid start circuit and lamp. The ballasts are claimed to be exceptionally quiet and to have minimum radio interference. The new lamp is bipin based, thus making the third lamp (preheat, bipin instant start and now bipin rapid start) to have identical external physical dimensions. Care must be exercised not to confuse these lamps for they are not interchangeable in luminaires accommodating bipin lamps. There remain other details of circuitry, installation and operation to be observed in applying this new development.

A new dimming circuit for fluorescent lamps was demonstrated for the first time at the September 1952 I.E.S. National Technical Conference. By means of specially designed control equipment and a special ballast, full starting voltage was maintained while changing current increased or reduced the light output. Forty-watt continuously-heated-filament fluorescent lamps were dimmed from maximum brightness to practically no light at all by a single knob control, resulting in a smooth transition very similar in effect to familiar incandescent filament lamp dimming. The British have had fluorescent dimming in theatrical and other applications for some time, as reported recently by Dr. J. W. Strange,[3] but the application is new in American practice.

The same rapid-start principle is also applied to another new lamp specifically designed for street lighting service. This new lamp operates at 100-watts and is designated as the F-100 T12. It fits into mogul bipin lampholders and has a nominal overall length of 72 inches. It operates at a current of one ampere, and the cool white type is rated at 5200 lumens. When used in typical street lighting luminaires, it is said to deliver as much light output at zero as it does at 80F. It is expected to give approximately 7500 hours life in street lighting service. These lamps are operated on a special 900-volt ballast which powers four lamps in series. The use of cathode preheat, inherent to the rapid start circuit, greatly reduces the size and weight of the ballast needed.

The 16-inch circline lamp has

reached the production stage this year. This completes the family of circline sizes announced some time ago. The new 16-inch size will operate at approximately 40 watts and deliver approximately 2200 lumens in the cool white color. One form of the lamp is equipped with rapid start cathodes. It will perform best when used with rapid start ballasts, but it is also expected to perform satisfactorily when operated on conventional 40-watt preheat circuits.

The fluorescent lamp story would not be complete without mentioning the significant release from one of the major executives in the lighting field that hit the new services on September 4, 1952. "Fluorescent Lamp Crowned New 'King of Illuminants' in U. S." was the title. Quoting from the release, "Government figures show the lamp industry produced 631,670,000 fluorescent tubes of all sizes — enough to reach from the earth to the moon and back — between 1938 and 1951. In 1941 the quantity of light produced by fluorescent lamps was only five and one-half per cent of the total. By 1946 the percentage had jumped to 25, and now for the first time the balance has been tipped in favor of fluorescent lighting. Fluorescent lamps now are being consumed at a rate of about 85 million annually."

The high efficiency and long life of fluorescent lamps have aided in the growth that now ends the 30-year reign of the incandescent filament lamp as the "king" of illuminants.

General Applications

Adaptability is a real feature of many practical lighting units on the market. The ingenuity of inventors and development groups has produced a great variety of display and accent lighting devices useful in a wide range of applications, both commercial and residential. Cleverly swiveled or jointed construction with flexible arms of several types make these luminaires suitable for direct and indirect lighting, and decorator colors make them attractive. Simple and positive mounting methods provide easy wall or outlet box attachment, or they may stand on their own bases.

One form of strip channel for incandescent spotlights uses a universally adjustable gimbal-type socket mounting which permits free adjustment of reflector spotlights for display lighting.

Recessed downlights for use with 200- or 300-watt lamps with concealed hinges and easy opening latches, have new convenience and more accessibility for maintenance. Baffles make them more light-tight, and a variety of lens patterns and diffusing bowls make them more versatile.

Store Lighting

Store lighting trends follow several paths toward better quality of lighting, and there seems to be general acceptance of the combination of warm white fluorescent with incandescent filament sources, either in the same luminaire or in separate units. More attention is being given to wall lighting of merchandise displays and to effective shelf and case lighting. Valances in several ingenious designs combine display with silhouette background and sign illumination, as well as providing diffuse wall lighting. Several rows of lamps are used in such valances and they can be positioned to provide for a wide range in size of display areas. Both interior wall case spaces and surface table or "island" displays can be lighted for effective customer appeal.

Louverall ceiling techniques alone or in combination with diffusing plastic continue in popularity with some designers. Spotlight, perimeter, niche and special shelf spots supply emphasis for featured displays. Luminous ceiling elements in square or circle patterns may combine multiple small fluorescent lamps with a center incandescent filament downlight in another design trend which can offer many possibilities for the architect's individual concepts.

Many of the newer luminaire designs have been made wider and are in better scale with large interiors. They may have more lamps per luminaire or the lamp spacing may be on wider centers. Such units, either recessed or surface mounted, are increasingly adopting the 96-inch slimline lamps as the preferred source.

In high traffic stores, supermarkets, drug and hardware stores, there is a move away from bare lamp unshielded strip units. Plastic side-shielded units with a deep V channel between lamps is one approach to this application, and an economical one. Maintenance is easy with these simplified designs since there are no cross louvers and only smooth unobstructed surfaces to clean. The general appearance of the store is more finished and attractive, and brightness contrasts are considerably reduced, avoiding much distraction.

School Lighting

One manufacturer is marketing a luminous indirect luminaire which is claimed to more than meet the brightness specifications of the I.E.S., A.I.A. and A.S.A., therefore particularly suited for school lighting.

School lighting luminaires in general follow previously determined trends, but more attention is being given to American Standard Practice. Among the newer techniques is the shielded ceiling system or grid[12] in which bare slimline lamps, operating at 200 milliamperes or 60 per cent normal brightness, are shielded by vertical baffles from normal view. The baffles may be of acoustically absorbent material, thus providing both light and sound conditioning in one package.

The fluorescent chalkboard lighting unit, announced a year ago is now a commercial catalog item. More attention is being given to special purpose teaching rooms: band rooms, art rooms, shop lighting, sewing rooms, remedial rooms; and lighting levels are commonly in the 40-, 50- or 60-foot-candle region.

A variation from usual "line" installations, parallel with room walls, is an Eastern school job where the design engineer has mounted the luminaires at an angle diagonally across the room, with a claimed higher utilization of vertical illumination.

Schools are recognizing that good electric lighting can result in savings in building construction and operation. Connecticut, Ohio and New York are among those states that now permit 9-foot and 10-foot classroom ceilings instead of 11 or 12 feet previously required. A Connecticut State Department of Education pamphlet states, "The higher quality of artificial lighting now available appears to justify placing greater dependence on it and less upon natural lighting." A Minneapolis report estimates "construction cost savings of about $400 per foot of ceiling height reduction when ceiling heights are reduced from 12 to 10 feet, assuming a 700-square-foot classroom."

Additional savings occur by reducing window heights with resulting drop in heat losses.

The Ohio Department of Health 1952 Handbook, "Health and Sanitation Standards for School Buildings," bases recommendations directly upon the American Standard Practice for School Lighting and gives credit to the I.E.S. for the material.

Plastic materials in sheet form for refinishing old school desk tops in simulated blonde wood or other light colored patterns in the 30 per cent to 50 per cent reflectance range are an aid in renovation of existing equipment to coordinate with improved lighting.

Daylighting

Daylighting design improvements should be considered at this point since new glass and plastic materials together with better engineering are helping to produce better room lighting. A paper, "Lumen Method of Daylighting Design,"[8] prepared for the Chicago Conference is an example of progress in this field. A technique is given for rapid computation of average, minimum and maximum work plane illumination in a daylighted interior, and is compared in usefulness for daylighting design to the Harrison-Anderson method in artificial lighting design.

Outdoor Lighting

Outdoor lighting has new tools also. A two-piece prismatic refractor in a rugged housing, in one example, provides an asymmetric light pattern resulting in a streamlined weatherproof luminaire useful for industrial, residential and protective lighting applications.

The Jones Beach Aqua-Stadium has a new type of 3000-watt incandescent projector which is reported to be capable of producing equivalent intensity and equal spot area for stage lighting at a 300-foot distance over previous designs limited to 200-foot throws. Mean beam candlepower is 900,000 obtained from the 3000-watt T32 biplane filament 100-hour life lamp.

Cornice lighting of building fronts with concealed 150-watt PAR38 flood lamps, mounted on 12-inch centers is a comparatively new outdoor lighting method and good results are reported.

Figure 1. Fluorescent lighting applied to parapet lighting on Consolidated Edison building in New York City.

A similar technique of lighting building fronts by fluorescent lamps deserves attention too. A special parapet design of easily accessible hinged luminaires, with weather protection uses 96T12 lamps for floodlighting a New York utility building. (Fig. 1).

Street Lighting

This year more attention has been given to a persistent problem in street lighting—how to get a realistic photograph of a lighted street. A relatively simple solution,[9] is through the use of an exposure calculator, which uses a "nomograph" chart of three scales. The photographer measures the "threshold brightness" of some part of the scene, then a straight line across the brightness scale and the chosen lens stop scale indicates the exposure time.

Philadelphia has taken a major move in its 15-year "Plan for the Modernization of Street Lighting in Philadelphia." The Vine Street installation uses 194 modern oval reflector-refractor luminaires. The 133-foot-wide thoroughfare will be lighted to a maintained average level of 1.3 footcandles. E-H1 mercury lamps are used at a mounting height of 33 feet and the luminaires are staggered at 75-foot spacing on each half of the divided roadway. Chestnut Street (135 luminaires) and Penrose Avenue Bridge (182 luminaires) have also been recently equipped with these new luminaires as part of the Plan.

Railway Lighting

The Boston Metropolitan Transit Authority has taken a forward step in transportation lighting: 88 special cars (Fig. 2) have been equipped with 250-watt headlamps mounted behind a 45-degree polarizing filter at the head of each car. In the operators' cab position is an analyzer with cross polarization to that of the approaching headlamp; when both filters are in use exceptional glare control is achieved. Fig. 3a shows typical glare in the operator's face when the filters are not in use and Fig. 3b speaks for itself as to the excellence of glare reduction. We can look forward to the day when the automotive industry adopts this technique and provides a method of controlling automobile headlight glare. (What a universal voice of thanks the motorist may express!)

The B and O Railroad added a new device on its Astra-dome cars, the installation of four 250-watt floodlights on the car roof, ahead of the dome section, to enable passengers to enjoy interesting scenery at night. The lighting is turned off when passing through cities and large towns.

Aviation

The aviation field hit a bottleneck in military plane production that was conquered by a light bulb, believe it or not. Miniature 28-volt, .04-ampere, grooved base incandescent lamps, only about half an inch long, are used literally by the hundreds in almost every military aircraft. Unable to supply the demands by hand production, a major manufacturer solved the problem by adapting the production to automatic machine methods, thus making a technical advance and at the same time overcoming a serious military production bottleneck.

Definite action was taken by several companies and government agencies toward higher candlepower aircraft marker lights to indicate an airplane's position at greater distances, both day and night. United Airlines developed a flashing marker light to be mounted on the peak of the vertical stabilizer of all their airliners. A PAR36 100-watt floodlamp is mounted horizontally, above which is a motor-driven rotating

Figure 2. Boston MTA train installation of polarized headlamp luminaires. The shield in the operator's cab can be swung into position to cross polarize with oncoming headlamp and reduce glare.

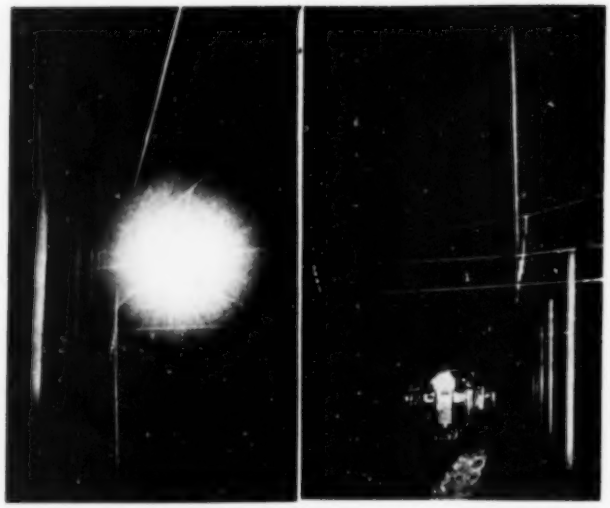


Figure 3a. (left) Typical glare in operator's eyes when polarizing units are not in use.
Figure 3b. (right) Vastly improved seeing conditions when polarizing filters are in proper adjustment.

mirror with dissimilar reflection surfaces which control shape, aim and flash of the beam through a deep red dome on top of the housing for the complete unit.

Airport lighting has variety too. At the Greater Pittsburgh Airport, the apron lighting is produced by two rows of low brightness refractor lensed incandescent luminaires flush mounted in the building walls. The units are similar to the luminaires reported last year in the St. Paul application on street lighting by fixtures flush mounted in building faces. The lower row uses 300-watt lamps and the upper row uses 1000-watt lamps, resulting in a large area of general illumination.

Another approach to the airport lighting problem is by use of fluorescent floodlighting. Logan Airport, Boston, has a test installation where one section of apron lighting is achieved by using the new 72-inch T12, one ampere rating, rapid start lamps in a twin lamp unit with polished aluminum reflectors and clear plastic enclosing cover. Proper weatherproofing of all components helps to make outdoor fluorescent units practical.

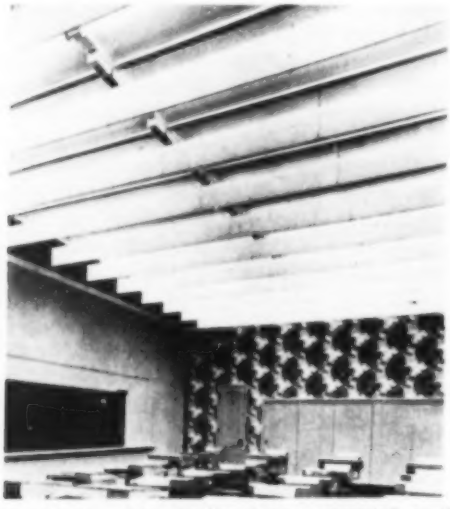


Figure 4. Ceiling system using slimline lamps, operated at 200 ma for low brightness, and translucent baffles.

Industrial

The trend toward more comfortable industrial lighting as predicted in last year's report has been markedly accelerated. Literally dozens of lighting equipment manufacturers have introduced luminaires specifically designed to meet the needs of this market. Although quite different in individual design, the basic lighting characteristics are similar. Units are finished white inside and out and are designed to meet the rigors of industrial service. The luminaires produce from 10 per cent to 40 per cent upward component, and industry literature seems to give more space to these products than to any other type.

The RLM Institute has recognized the need and prepared a new series of standards covering Industrial Fluorescent Fixtures directing 20 to 30 per cent of their light upward, providing 27 degrees of transverse shielding of the lamps and limiting brightness in the shielded zone to 40 per cent of bare lamp brightness. This is the first such recognition of the need for this performance.

Articles on the subject of this quality trend in industrial lighting appear in many current issues of the electrical press. Typical of these is "Specifications for Production Lighting" in the July 1952 issue of ILLUMINATING ENGINEERING in which it is estimated that 75 per cent of the potential industrial

lighting market will be in the semi-direct category. A number of Merit Awards were made by the Fourth International Lighting Exposition on installations of this type. (Fig. 5).

The improved quality of illumination through the use of lighting units that have a substantial upward component requires that the paint used on ceilings and upper walls must be highly efficient in reflecting light; otherwise, much of the upward component is lost by absorption and does not reach the working plane. Since white paint reflects more light than any color, the use of white ceilings with this type of luminaire is standard practice. Advances in paint chemistry now make it possible to produce white paints on a commercial basis having a reflection factor over 90 per cent. These intensely white ceiling finishes are available for brush and spray applications at reasonable cost, and may well be considered as a part of the lighting job when this type of luminaire is recommended.

Paint technicians point out that light colored paints lose their reflective power at a slow but fairly uniform rate, depending upon the amount of dirt accumulation, fumes and other conditions. This depreciation is about 3 to 5 percentage points of light reflection per year, and the *rate* is about the same whether the paint starts at a high reflectance or low. Thus, a paint having an initial reflectance of 80 per cent might be down to 70 per cent at the end of three years, while an intense white having an initial reflectance of 90 per cent would end a three-year period at 80 per cent.

Since white paints begin to take on a grayish look when their reflection factor falls much below 70 per cent, an important factor in prolonging the useful life of a white paint job is to have its reflectance as high as possible when applied. In this manner, the length of time before it will require repainting because of appearing gray can be prolonged substantially.

One method of contribution to the spread of knowledge about improved lighting was a practical form of touring show, "Lighting at Work." The show was unique in its use of a new presentation technique in which live actors appeared to be part of a projected scene, producing for the audience the illusion of full scale, office, factory and other interiors "on stage." Still and motion picture projectors were sometimes used simultaneously, the latter showing past or future scenes in the experiences of the main characters who were also appearing "in person."

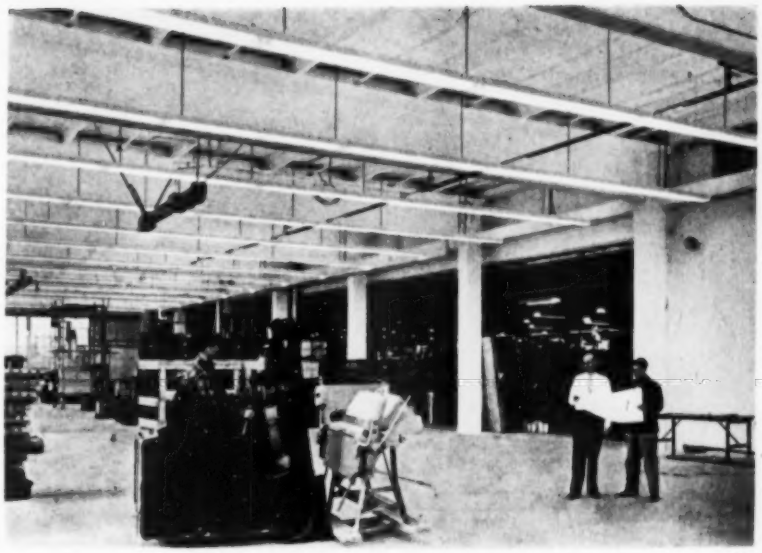


Figure 5. New upward component industrial luminaires in combination with light surface finishes produce a striking contrast with the direct industrial units in the background.

Other developments in the industrial field include:

1. A new prismatic reflector high bay dome unit for use with the new 1000-watt mercury lamp, plain or color corrected. An easily cleaned smooth inside glass surface aids in maintenance, and there is easy socket adjustment, a ventilated socket housing and a rugged tripod support to align and protect the reflector.
2. An "explosion proof" incandescent 500 watt floodlight for use in hazardous locations where explosive or flammable gases are present.
3. An "explosion proof" bactericidal luminaire to house the G36T6 slimline bactericidal lamps. Such units are today essential in pharmaceutical manufacturing of "wonder" drugs, in treatment of blood or other biologicals, and where utmost sterility must be maintained. Another manufacturer's type of a similar luminaire is a straight line unit housing two high intensity bactericidal tubes and equally suitable for ceiling mounting, direct or indirect, and for flush mounting in sterile hoods.

Materials

Research and invention encourage progress in the use of light by providing improved materials to aid in application. Photo-reproduced patterns in glass have been previously reported but their variety continues to widen the field of usefulness. The great facade of the new United Nations General Assembly Building uses full length panels of translucent glass with a permanent photoprocessed marble pattern that blends realistically with the real marble vertical column faces. The entire front of the building appears to be one tremendous marble expanse. The processed glass transmits diffuse light to thoroughly illuminate the huge entrance hall, approximately 100 feet in height and several hundred feet in width.

The pattern of office building construction featuring glass walls, as exemplified last year by the United Nations Secretariat building, seems to be spreading in popularity. One metropolitan office building, recently completed, seems to be an all glass exterior and is already a familiar member of the New York skyline. Since there are no windows that open, a special vertical "railway" car moves up and down the external building surfaces to clean the glass. More than three miles of glass lensed, recessed, individual troffer

Figure 6. Corrugated plastic ceiling in Equity Bank at Cleveland features light and sound control as well as conditioned air diffusion.

units produce an average of 45 footcandles on office desk surfaces.

Glass fiber panels, decorative as well as useful transmitters of light, are being applied to luminous ceiling installations with pleasing results. Placed between ceiling troffers and lighted by "spill light" through slotted or louvered sides of the luminaire or from extra bare lamps above the ceiling, the fibered panels reduce brightness contrast and contribute to an overall impression of visual comfort.

New varieties of prismatic lens plates and prismatic reflectors are helping to achieve lower brightnesses and higher efficiencies. One manufacturer has a concave lens for recessed lighting units. The receding surface, from the observer's view, has a stepped prismatic design resulting in uniform low brightness over the entire surface of the lens. Efficiency is said to be up 25 per cent and brightness down by more than 50 per cent.

Glass blocks are now available in a 12-inch square prismatic form which can be light-directing, sending as least 60 per cent of the transmitted light upward. Suitable for use on any exposure, the blocks accept and transmit light from all regions of the sky. They are intended to be used above the eye-level. Another form is light-diffusing, with a substantially uniform vertical light distribution; the brightness in all directions is sufficiently low for use below eye-level.

Torchere bowls have a "new look" too as well as new ruggedness. A "vise-grip" light-weight steel neck is made an integral part of the shade resulting in great rigidity. The shade will stay put even if the lamp is inverted!

New plastic materials and improved fabrication of familiar plastics is a lush field for any reporter. Certainly plastics have joined with glass to give the illuminating engineer and designer almost unlimited expression to skill and imagination.

Luminous plastic ceilings, both vinyl and acrylic types, are popular in the corrugated sheet form and some installations now have Underwriters Laboratory approval. One illustration is the acrylic system, Fig. 6, in a Cleveland bank. This installation incorporates light and sound control plus diffusion of conditioned air. The sound control is provided by suspended acoustic baffles over the work area; the conditioned air is introduced into the plenum and enters the room through the many openings at the edges of the corrugated sheets.

Figure 7. A new electronic form of direct reading brightness meter with a wide range of measurement.

The Boston Public Library now has eight galleries[13] lighted with an acrylic luminous ceiling in combination with directional fluorescent and incandescent lighting. The luminous ceiling gives a totally diffused illumination, free of shadows and reflected glare. Higher light levels and full color values for the paintings are supplied by directional louvers and recessed incandescent spots.

One major manufacturer in the field combines, in its Engineering Building, the luminous ceiling in the main drafting room with sky-glare control obtained by using gray acrylic glazing above the clear glass vision strips in the windows. With an average of 118 footcandles there is no objectionable glare and the 3:1 brightness ratio is said to be more than satisfied. The same type of neutral gray plastic has been applied to windows below the glass block wall sections in a Detroit elementary school for reducing glare from sun and sky. This is a new type of fenestration to aid in the general problem of light control.

In the luminaire field styrene plastic offers promise in large extruded shapes for diffusers; the acrylic or vinyl types also can be incorporated into large area sources of illumination. Squares, circles, ovals, almost any reasonable geometric form can be produced with these plastics, and a whole new region of practical investigation lies ahead.

Street lighting units, both fluorescent and incandescent, use plastic shields to reduce vandalism, and acrylic skylights are being applied to commercial and institutional buildings. These clear "bubbles" are prefabricated, mounted and ready to install as part of the building structure. They may well be an important trend in the utilization and control of natural daylight in interiors. A supplement also provides

Figure 8a. New Certified wall lamp has a half-curved shade permitting close-to-wall suspension.

Figure 8b. Pin-up lamp with diffusing plastic bowl and adjustable swinging bridge arm with counterweighted line.

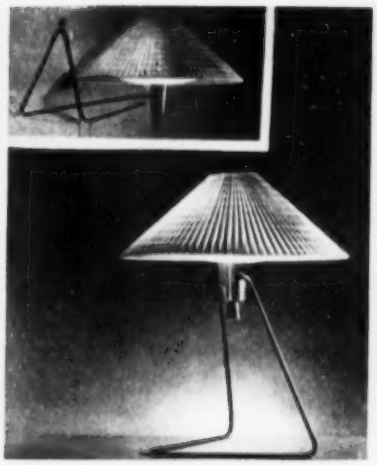


Figure 8c. Adjustable table lamp tilts to any angle and is easily changed to a pin-up lamp.

for double doming wherein artificial illumination and natural daylight may come from the same apparent source, luminaires being concealed in walls between the domes.

The new Brightness Spot Meter is designed to measure the brightness of a very small area at any distance from four feet to infinity, through the use of a photocell, amplifier and micro-ammeter system. It is, therefore, completely independent of the variable sensitivity of the observer's eye and requires no matching of brightness. The sensitivity of the instrument is extremely broad, covering the range from 1 to 1,000,000 footlamberts over its five ranges (Fig. 7).

Residential Lighting

A practical booklet of "Home Lighting Ideas" was published by one manufacturer covering the use of incandescent and fluorescent lamps in the home, where and how to use lamps, sizes and shapes of diffusion globes, recommended wattages and simple maintenance of portable lamps. A revised form of the "Certified" wall lamp features a half circle shade for close attachment to vertical surfaces (Fig. 8a). Last year's report included a hand model of a lowering type dining area luminaire that represented a combination of European design with American mechanical devices to produce an adjustable source that is both practical and decorative. Many readers will remember "grandma's lamp" with its kerosene lamp bracket on a chain gadget that could raise or lower it as desired. The new luminaires show the influence of early design modified by modern fabrication. One type has the reel mechanism in a ceiling canopy, another houses the mechanism in a ball or cylinder in the middle of the suspension cord. Still another type uses a pull cord counterbalance with a coiled feed wire acting as the tension.

Indirect wall urns in plaster, metal or plastic materials are useful for television surround lighting. One form of TV lamp uses a book cover design with tooled leather binding and is adaptable to modern or traditional decoration. Pin-up lamps take a new look. Now they can be used as a swing arm bridge, adjustable from the wall and raised or lowered from the hanging position (Fig. 8b). One manufacturer describes an "Up-Down-Sideways" pin-to-wall lamp which seems to be all inclusive.

Adaptor units of several types are now available to convert existing incandescent sockets for use with linear fluorescent, circline or multiple incandescent lamps; the styling may run from colonial lamps to modern shielded fluorescent.

Since the announcement last year of improved valance lighting units, many manufacturers are offering complete housings with traverse rods and a variety of finishes and sizes to fit almost any home requirement. Recessed ceiling units may have variable beam spots; one type uses a G16 100-watt lamp and provides about 20 to 72 degrees of beam spread by a simple screw-driver adjustment.

Figure 8d. Jointed desk lamp has a simple friction clamp for attachment to work surfaces.

Combination lighting and heating elements are useful; a ceiling bathroom unit may combine a high wattage heating coil with an air recirculation device and a general light source, or the heating unit may be embedded in shatter-proof glass and provide light from a center reflector in another combination.

"Gadget" devices reflect the ingenuity of inventors and also encourage the use of light in places where no easy source has previously been available. Inexpensive closet lights come equipped with door switches and extension cords, to eliminate fumbling in the

dark when the hands may be full of clothes. An "adjustable harp" is claimed to be useful for decorative lamps in combination with any size bulb from 25 watts to the R-40 white bowl, and there are a variety of table and floor lamps that are cleverly built with jointed and balanced arms or clamps which permit almost any conceivable positioning of the device. Manufacturers should be praised not only for the new designs but in most cases the lamps are well shielded with diffusing plates or shades that indicate considerable effort to apply good lighting principles.

The importance of surround lighting to relieve TV tube glare is generally recognized and background indirect lighting behind or above the set is common. One manufacturer has made the frame around the picture tube luminous, giving a border of light to produce brightness gradation and relieve strong contrasts, thus contributing to viewing comfort. The plastic frame is softly lighted by low current cold cathode tubing which is adjustable in intensity to suit the viewing conditions.

Lighting Education

As one watches the activities of I.E.S. sections and chapters and individual members, it is quite obvious that we take seriously our general obligation to the "dissemination of knowledge." Month by month all through the United States, and in Canada, educational courses are scheduled, elementary and advanced, covering fundamentals of illumination, light source development and application, and illuminating engineering.

The I.E.S. Committee on Lighting Education in its 1951 Survey Report reached these conclusions:

1. The number of courses dealing with illumination, both required and elective, is less today than in 1935 (in U. S. and Canadian engineering schools).
2. Less emphasis is being placed on these courses today than in 1935, shown by the fact that the percentage of required courses has decreased while the percentage of elective courses has increased.
3. A smaller percentage of men in the engineering educational field, as a whole, feel that courses in illumination should be required in a four-year curriculum (now—21 per cent, in 1935—23 per cent) and in a five-year curriculum (now—40 per cent, in 1935—50 per cent).

It would appear, then, that there is need for more attention to illuminating engineering at the college level. One committee member writes: "With a demand for trained illuminating engineers, not just converted electrical engineers, the educational field in illuminating engineering will expand and more colleges will offer Options in Illuminating Engineering instead of a course or two in the subject."

In many practical ways we are encouraging the lighting practitioner. Student Architect Awards, Lighting Clinics, Planned Lighting Awards, Industrial and Commercial forums, "My Most Interesting Lighting Job" contests, National and International Lighting Expositions, motion pictures, traveling demonstration "shows," research projects, lighting education publications—all these forms of activities show Progress.

The *I.E.S. Lighting Handbook* in its second edition is a noteworthy contribution in lighting education. Recognized as the top authority in the field, the *Handbook* was extensively revised and enlarged from the first edition and is an essential "tool" in the hands of all engineers as well as a standard reference source for lighting information.

At the International Lighting Exposition in Cleveland an informative report from John Ronayne of the Better Light—Better Sight Bureau stressed the accomplishments of the Planned Lighting Program since its inception in 1946. As Mr. Ronayne states, "More than 400,000 children have to date received this training. In hundreds of schools, light-sight education is a permanent part of the curriculum. A flatteringly high percentage of school administrators buy the teaching aids with their own funds, as a worthwhile expenditure on useful, practical instruction for their students."

The work of the C.I.E. (Commission Internationale de l'Eclairage) can properly be classed as "educational." The 1951 Stockholm meeting elected Dr. Ward Harrison as President. Mr. C. A. Atherton has been Honorary Secretary since the 1948 meeting in Paris. Typical of the trend in C.I.E. activities, a permanent Papers Committee has been named similar in function to our I.E.S. Papers Committee; a "Scope" Committee reviews the range and distribution of technical assignments; technical secretariats are active in fields of automobile headlighting, color and glare, vocabulary, and television studio lighting and viewing conditions.

The I.E.S. participated in celebrating the "Centennial of Engineering" at Chicago during September 1952. The final section of the Progress Report, as presented there, featured authentic furnishings and period dressed models in a tableau depicting typical home lighting in 1852 and 1952. A paper entitled, "Electric Lighting in the First Century of Engineering," given by one of our members,[15] represented both I.E.S. and A.I.E.E. observance of the historical contribution of lighting. Other papers included "The Contribution of Engineering to Optical Hygiene and Vision"[16] and "Lighting as a Means for Promoting Safety."[17] Many I.E.S. officers and members joined the schedule of meetings fittingly observing the century milestone, and an illuminated scroll was presented to the American Society of Civil Engineers in recognition of its century of service.

Military and Government

The Army Engineer Research laboratories reported the successful application of evaporated silica film as a protective coating on evaporated aluminum reflectors for all field equipment where high reflectance and durability are required under adverse conditions. A new magazine-feed carbon arc lamp features:

1. Water-cooled positive head, permitting operation at 200 amperes with a brightness of 1600 candles per square millimeter.
2. Magazine feed of positive carbons in clips lasting approximately two hours and replaceable during operation.
3. Disk negative having a life permitting an entire night's operation.

The Navy Department has been active for several years through its Lighting Improvement Program, in redesigning existing luminaires and developing new types for shipboard use. Both fluorescent and incandescent types have been brought to a high degree of efficiency and at the same time the

Figure 9. Chicago group display of U. S. Navy fluorescent and incandescent shipboard luminaires.

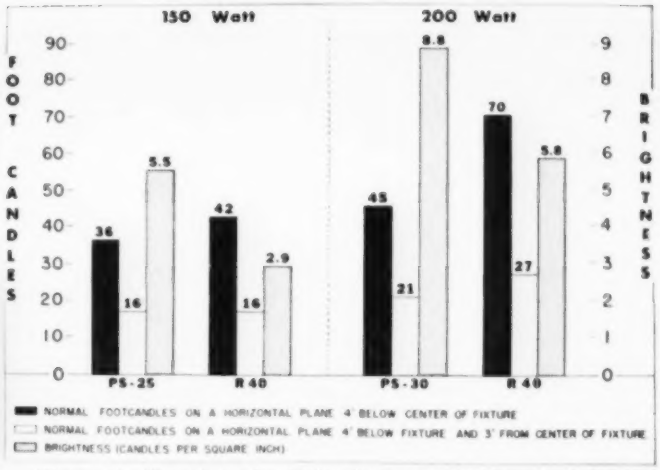


Figure 10. New Navy luminaire design plus change to R40 lamps from previous PS types resulted in marked gain in footcandles and sharp decrease in brightness.

basic principles of good lighting promulgated by I.E.S. have been observed. The result is a group of lighting units giving exceptionally good illumination yet meeting the severe structural demands characteristic of naval applications. We were fortunate in having the Bureau of Ships exhibit at the Chicago Progress Report (Fig. 9. An example of what was accomplished in one instance is shown in Fig. 10. The substitution of R40 type lamps for PS types of equivalent wattages in the same incandescent unit, modified from earlier designs and well shielded, gave significant improvements in footcandles and in brightness reduction. New types of lampholders, lamp locks, and luminaire shock mounts have helped in achieving rugged designs. Certain fluorescent types have been shown to be more shock resistant than incandescent units. Fluorescent and incandescent overhead luminaires, fluorescent desk lights, fluorescent switchboard units, vaportight fluorescent units, electronically shielded fluorescent luminaires, high bay luminaires and two-lamp indicator lights were reported. In all the development work the objective was always to provide lighter weight, better performance and higher efficiency. In one instance, a new fluorescent unit, compared to an earlier incandescent type, resulted in a weight reduction of almost one-half, power consumption was reduced to one-third and light output more than doubled. In addition the new fluorescent unit caused far less glare on dial surfaces.

The Atomic Energy Commission reported that on December 20, 1951 the first known production of useful electric power from atomic energy was demonstrated. Dr. Walter Zinn, and his associates, conducted the tests and there is historical interest in the choice of 100-watt incandescent lamps to consume the first release of converted nuclear energy from the recently completed Experimental Breeder Reactor. Fig. 11 may well become a familiar text book illustration for future students. On the next day, December 21st, all the electrical power in the demonstration building was supplied from atomic energy.

The White House was reopened this year after a complete internal reconstruction. Considerable attention was given to the restoration of the lighting equipment. They were put back as nearly as possible in their original architectural condition. Office and work spaces were variously treated according to need or preference. Luminous indirect fluorescent lighting was used in some places. Louvered bottom, open top fluorescent types, with luminous side panels, were more useful in other locations. Recessed fluorescent units and vaporproof incandescent concealed luminaires were applied where special protection was required.

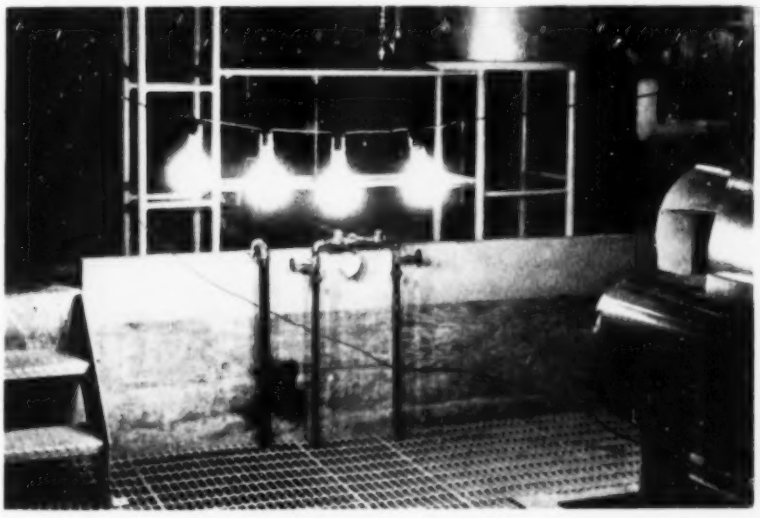


Figure 11. The first known production of electric power from conversion of atomic energy lights 100-watt lamps. Photo taken December 20, 1951 at the A.E.C.'s National Reactor Testing Station.

Figure 12. (left) New lighting in The Lords Chamber in London.

Figure 13. (above) Floodlighted canal scene in Bruges, Belgium, attracts more tourists.

The project was one of renovation and this purpose was closely observed, especially in public spaces, most of which are historical. An example can be cited of the chandeliers in the East Room. They were revised slightly to permit the incorporation of reflector flood lights within the units, providing an indirect component but not impairing the character of the crystal chandeliers.

We are thankful to President Sam Hibben for sending us the following paragraphs which add historical background to the White House narrative:

"It was in the White House during the Presidential term of James K. Polk that on April 7, 1845 there was submitted to Madam Polk the first recorded genuine planned lighting specification. Our Historical Committee of the I.E.S. has a copy of this document, the work of a certain Col. Lewis, and the details of this first specification will perhaps later be published. It is now in draft form and goes into considerable detail as to costs of new versus old lighting equipment. Madam Polk was an economist who objected to paying $4.00 per hour to light the major first floor rooms, chiefly the famous East Room and she was well satisfied with the economy effected by the new system of rock oil (kerosene) which in the East Room, for instance, was figured at some $253 annually compared to the $1050 which was the cost when using candles. The oil lamps of 1846 were of about 14 candlepower (one 200-watt electric lamp of today emits approximately 295 cp). It was estimated that under the new and revised system of 1845 the East Room was 'brilliantly illuminated for a Presidential levee' at an average level of half a footcandle.

"The item of most interest was perhaps the fact that the first great crystal chandeliers in the East Room after they had been piped for gas were thrown out for junk but later rescued and are now hanging in the Vice President's suite in the Capitol Building, etc. Many redesigns of lighting have occurred, the recent renovation happily leaving some of the fine old crystal and some historic sconces undisturbed but nevertheless reconditioned and repaired. Many of today's luminaires were installed in 1902 by E. F. Caldwell and Company under the direction of the architectural firm of McKim, Mead and White."

Lighting in Europe

The foreign correspondent members of the Progress Committee have been thorough and very cooperative and the Chairman wishes to express his appreciation for this part of the Report to:

Mr. Jean Chappat
Compagnie des Lampes
Paris, France

Mr. L. C. Kalff, Gen'l Art Director
Lighting Service Department
Philips Company
Eindhoven, Holland

Mr. Ivar Foleker
Swedish Lighting Association
Stockholm, Sweden

Mr. E. B. Sawyer, Manager
Lighting Service Bureau
Electric Lamp Manufacturers Assoc.
London, England

Last year's Report spoke of the new lighting installed in the House of Commons. This year the House of Lords renovation was completed and the lighting system modernized. As expressed in one report — "To provide lighting at modern levels of illumination, without clashing with the atmosphere associated by tradition with an institution that is as old as the centuries, is no easy problem — its successful solution no mean achievement." Fig. 12 illustrates one view of the Lords Chamber. The fittings originally designed by Augustus Pugin have been retained in their entirety. Previously they contained clusters of five 40-watt lamps at each of the six points of the unit. These are now replaced by a single 150-watt lamp in a prismatic reflector at each point, and the average intensity at the working plane has been increased from 1.5 footcandles to 9 footcandles, while the consumption has been reduced from 1200 to 900 watts.

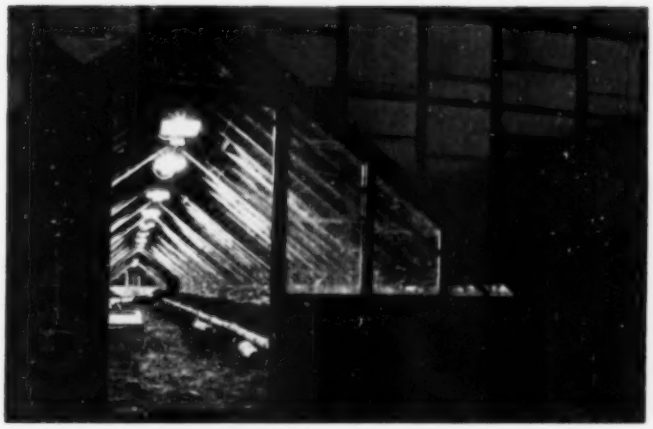


Figure 14. (left) Newly opened Demonstration Laboratory for lighting at Eindhoven.

Figure 15. Hothouse lighting with high pressure mercury lamps in Holland.

Figure 16. Hot cathode lighting in American Tobacco Works shed building at Copenhagen.

Figure 17. Fluorescent lamps ballasted by silver bowl incandescent lamps make an attractive store lighting application in Holland.

A further modification involved the addition of a trumpet shaped brass unit inside the luminaire which, with incorporated lamps, throws light upon the magnificent painted ceiling, hitherto little but a dark background to the bare lamp cluster.

The tourist trade on the Continent is recognized as an important local enterprise. More and more attention is being given to the use of light as an aid to attract tourists. Fig. 13 shows a view along the canal through the medieval town of Bruges, Belgium. The historical buildings and beautiful trees and gardens are lighted with mercury, sodium or tungsten floodlights. Little motorboats take visitors on an hour-long tour through the canals and one sees the old buildings and surroundings in a new way. The centuries-old architecture is revealed in new beauty and detail. In France many of the famous chateaux, cathedrals and historical buildings are floodlighted for night viewing.

Figure 14 shows the reception hall and exhibit areas in the new Lighting Demonstration Laboratory at Eindhoven. On the main floor can be seen part of the light source display, a shop window and a school room or office room arrangement which can be changed into a shop area by opening folding doors in the wall and turning over the desk tops which then become lighted show cases. Vari-colored neon tubes feature the center ornament and the wooden ceiling has cut-out sil-

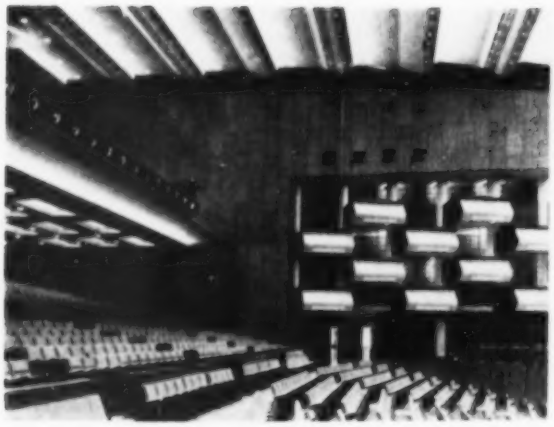


Figure 18. Royal Festival Hall, one of the permanent buildings of the Festival of Britain; lighting illustrates modern English practice.

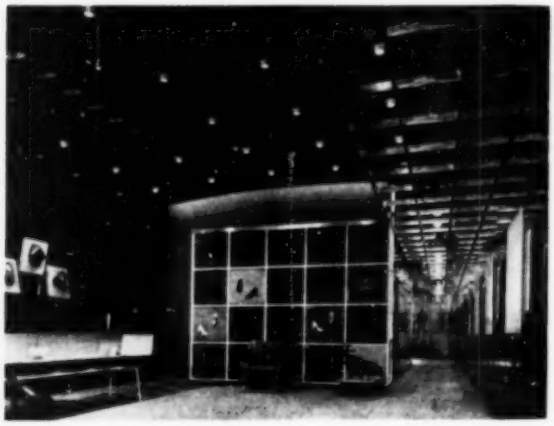


Figure 19. Another modern British approach is the dramatic ceiling and wall lighting in this London shoeshop.

houettes with matte glass made luminous by recessed fluorescent tubes. The balconies carry exhibit demonstrations and behind the rattan wall is a lecture and projection room.

One of the world's largest floating docks, at Rotterdam, has been lighted by fluorescent luminaires to provide continuous work opportunities. Applications of this kind along with fluorescent floodlighting mentioned elsewhere in this report give evidence of the increasing versatility in applying fluorescent sources.

High pressure mercury lamps, 450-watt, 20,000 lumen, are used in hothouse lighting in Holland. Tomato plants, for instance, are irradiated during five to six weeks of their development, with the mercury light on from midnight to about 10 a.m. The radiation is said to stimulate growth and strengthen the plants prior to transplantation (Fig. 15).

A representative method of factory lighting is shown in Fig. 16, the American Tobacco Works at Copenhagen. Two rows of 65-watt lamps are built into the beams and two rows along each of the ceiling surfaces provide 30-40 footcandles of illumination.

The use of fluorescent lamps ballasted by silver-bowl incandescent continues as a fairly standard practice in store and public building applications. They may be combined in single luminaires as in Fig. 17, or separated as individual units.

The Royal Festival Hall, Fig. 18, is one of the permanent buildings of the Festival of Britain and a good example of modern English interior decoration and lighting technique. Another modern British approach using dramatic ceiling and wall effects, in a shoeshop in London, appears in Fig. 19.

An underpass traffic tunnel, more than a mile long, under the Croix-Russe at Lyon is the longest in Europe. An ingenious solution of the transition problem from bright daylight (maybe 15,000 ft-c) to interior tunnel lighting of 3 ft-c by day, and 1.5 ft-c by night, has been made by a flexible system of varying the lamp combinations (Fig. 20). Hundreds of warmtone instant start 40-watt fluorescent lamps line the tunnel walls in single, double, or triple lamp louvered units. At each entrance is a curtain of 26 continuous rows of 8-foot instant start lamps switched in groups

Figure 20. Croix-Rousse underpass tunnel at Lyon, France. Entrance lighting can be adjusted to variable outdoor lighting levels.

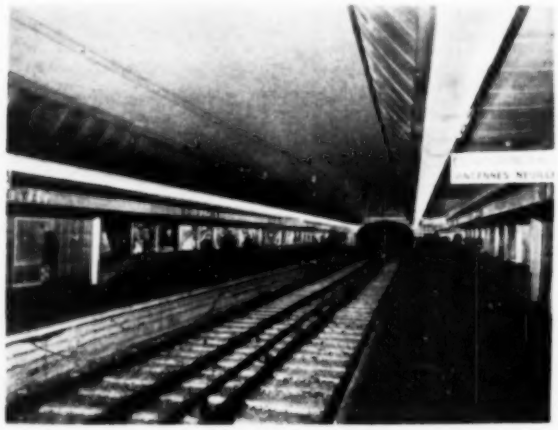


Figure 21. Continuous row "superwhite" fluorescent louvered luminaires produce 10 footcandles of general illumination in Paris Metro station.

Figure 22. Luminaires with 4-5-foot 100-watt fluorescent lamps produce 17,600 lumens on the Cours de Vincennes, in Paris.

of 6, 14 or all 26 tubes. The transition from entrance to interior tunnel is adjusted in three steps from 100 to 25 to 9 ft-c, and the first two sections can be further adjusted in three steps to fit with outdoor daylight conditions, whether bright, fair or overcast.

The Paris "Metro" station, Franklin D. Roosevelt, was entirely remodeled this year and equipped with "super white" (4200K) 40-watt fluorescent lamps in louvered fixtures along the walls, producing 10 ft-c general illumination. Twenty-two showcases (4 x 7 feet) line the walls and are lighted by deluxe "super white" lamps, four to each case. It is said that expenses are entirely paid by the publicity charges for the show cases.

Mr. L. Gaymard, Chief Engineer on Street Lighting at the "Electricité de France," submitted through Mr. Chappat a fine summary of street lighting practice in France. The original Avenue du President Wilson installation in 1947 proved to be such a success for fluorescent lighting that in 1952 Paris fluorescent street installations alone exceeded 3000 units. Many towns in surrounding provinces are installing the fluorescent luminaires. Types now in use include:

a. Luminaire using six 2 foot lamps for residential areas.

b. Luminaires using two 4 foot lamps (4,500 lumens) or three 4 foot lamps (6,700 lumens) for tree lined streets and average width thoroughfares, usually positioned about 60-80 feet apart.

c. Luminaires for two 5 foot lamps (8,800 lumens) or four 5 foot lamps (17,600 lumens) especially designed for main thoroughfares. Most of these are aluminum alloy, with anodized aluminum reflectors and acrylic plastic covers.

d. Illuminated pylons.—More than 1200 of the famous Paris pylons have been converted to fluorescent lamps, one 3-foot 40-watt lamp for each pylon, and these five-foot pillars are agreeably lighted, it is claimed, from both the pedestrian and driver point of view.

In all cases, Mr. Gaymard reports, the "warm tone" color is standard for street lighting and "since we are punctilious in the matter of color, we avoid having streets lit by tungsten opening into streets lit by fluorescence, and we use mixed mercury-vapor and tungsten lamps (250 wattts - 5000 lumens) to make the transition." The city of Bordeaux has the first experimental street installation using color-corrected mercury lamps. On existing poles 120 feet apart at a height of 27 feet are two lanterns. One is directed toward the sidewalk and equipped with a 125-watt high pressure color-by 125-watt filament; the other is directed toward the street and equipped with a 125-watt high pressure color corrected mercury source. Illumination on the sidewalk is reported as one to two footcandles and on the street as 0.8 to 1.1 footcandles.

One manufacturer reports on a new type cathode which combines the advantages of hot and cold cathodes into a single instant starting electrode. The cathode is made from a metal cup of very small dimension (about .25 cm^3) and is mounted with the opening toward the stem, incorporating an emissive deposit which is especially rugged. The lamp is said to have a cathode drop of the same order as hot cathode filaments; to have great flexibility of operation, 200 to 500 milliamperes for one model and 80 to 200 milliamperes for another; and to have very long life.

For the first time in its annals, the French I.E.S. (Association Francaise des Eclairagistes) met outside of Paris, at Toulouse, in May 1952 for a week's conference. The American delegation included Messrs. C. A. Atherton, E. W. Commery, A. H. Manwaring and M. N. Waterman.

References and Bibliography

1. Barr, A. C., and Thayer, R. N.: "Slimline Instant Start Fluorescent Lamps," *General Electric Review* (March 1952).

2. Hinman, D. D., Keiffer, R. L., Strecker, C. E.: "Fluorescent Lamp Performance on Sequence Start Ballasts," ILLUMINATING ENGINEERING, Vol. XLVI, No. 11 (November 1951).

3. Strange, J. W.: "The Dimming of Fluorescent Lamps and Its Application to the Theater," *Transactions I.E.S.* (London), Vol. XV, No. 4 (April 1950).

4. Strange, J. W.: "The Dimming of Fluorescent Lamps and Their Use in the Kinema," *British Kinematography*, Vol. XX, No. 6 (June 1952).

5. Lowry, E. F.: "The Physical Basis for Some Aspects of Fluorescent Lamp Behavior," ILLUMINATING ENGINEERING, Vol. XLVII, No. 12 (December 1952).

6. Burns, C. H., and Bachman, H. E.: "A New Lead-Lag Ballast for Discharge Lamps," ILLUMINATING ENGINEERING, Vol. XLVII, No. 10 (October 1952).

7. Lemmers, A. E., and Brooks, W. W.: "New Fluorescent Lamp and Ballast Design for Rapid Starting," ILLUMINATING ENGINEERING, Vol. XLVII, No. 11 (November 1952).

8. Biesele, R. L., Arner, W. J., Conover, E. W.: "A Lumen Method of Daylighting Design," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 1 (January 1953).

9. Knowles, T., and Toenjes, D. A.: "Techniques for Photography of Lighted Streets," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 1 (January 1953).

10. Taylor, G. J.: "Industry Needs Quality Lighting," *Electrical Construction and Maintenance* (January 1952).

11. Linforth, E. M.: "A Study of Large Area Acrylic Ceilings," ILLUMINATING ENGINEERING, Vol. XLVII, No. 4 (April 1952).

12. Benson, R. S., and Church, E. H.: "Grid Systems for Classroom Lighting," ILLUMINATING ENGINEERING, Vol. XLVII, No. 1 (January 1952).

13. Feather, M., and Thompson, W. W.: "Combination Lighting for Viewing Paintings," ILLUMINATING ENGINEERING, Vol. XLVII, No. 5 (May 1952).

14. Fraser, H. D., and Till, W. S.: "Color Correction and Other Important Improvements in Mercury Lamps," ILLUMINATING ENGINEERING, Vol. XLVII, No. 4 (April 1952).

15. Oetting, R. L.: "Electric Lighting in the First Century of Engineering," A.I.E.E. Technical Paper 52-267 (August 1952).

16. Hibben, S. G.: "The Contribution of Engineering to Optical Hygiene and Vision," Centennial of Engineering Paper (September 1952).

17. Crouch, C. L.: "Lighting as a Means for Promoting Safety," Centennial of Engineering Paper (September 1952).

New I.E.S. Publications, 1951-1952

1. I.E.S. Lighting Handbook, Second Edition, 1952.

2. Recommended Practice of Sports Lighting, 1951.

3. American Standard Practice for Industrial Lighting, 1952.

4. Lighting of Central Station Properties, 1951. Recommendations for control and load dispatch rooms.

5. Transportation Lighting, 1951. Recommendations for interior lighting for buses, street cars, rapid transit and railway trains.

6. Current Lighting Practice for Television Production, 1951.

7. Functional Visual Activities in the Home, and the Location and Extent of the Associated Areas To Be Illuminated, 1951.

8. I.E.S. Guide for Photometric Testing of Floodlights of 10 to 160 Degree Total Beam Spread, 1951.

9. I.E.S. Guide for Outdoor Illumination Tests, 1951.

T E L E C A S T

LIGHTING NEWS OF CURRENT INTEREST

New York Residence Lighting Forum To Present Four Outstanding Panels

Arrangements for a series of four exceptionally interesting lighting panels on related subjects to be presented this winter and spring, have just been completed by the Residence Lighting Forum of the New York Section of I.E.S.

The first panel, held January 21 in New York City, featured "Ocular Physiology in Relation to Illumination." Dr. Gerald Fonda, Assistant Professor of Ophthalmology at the New York University Post Graduate Medical School presented the medical man's point of view on this subject. The psychologist's view was represented by Mr. Charles R. Kelley, Assistant Professor of Psychology and Associate Director of the Division of Vision Research at North Carolina State College, whose topic was "Psychological Aspects of Visual Perception in Relation to Illumination." Mr. Kelley defined the present limits of psychological knowledge resulting from research in this field, and outlined some of the problems which have received relatively little study so far. Mr. Berlon Cooper, Eastern Editor of *Electrical Construction and Maintenance*, concluded the program by presenting a digested bibliography of published work relating to the subject.

The meeting was the first in a series of four related programs to be presented by the Residence Lighting Forum in the coming months. The second will be held on February 19, at the Museum of Modern Art, with Mr. Philip Johnson, Director of the Department of Architecture and Design, as moderator, and a panel of experts selected by the Museum. The subject of the discussion will be "The Lighting Art as Part of Architectural Experience and Its Relation to Light in Paintings."

The March meeting, to be co-sponsored by the publication *House and Home*, will have the title "Why Lighting in Speculative and Builders" Houses Has Not Been Tolerable, and a Report on the Likely Future." Mr. Douglas Haskell, Editor of *House and Home*, will be moderator. A panel of building experts will discuss the merchandising, financing and construction of these houses, and a lighting group will debate the place of architectural vs. portable lighting.

The April meeting will discuss "The New Demands of the New Architecture for New Solutions to New Lighting Problems," with Mr. Richard Kelly, lighting consultant, as moderator. Taking part in the discussion will be Mr. Gordon Bunshaft of Skidmore, Owings and Merrill, New York, Mr. Louis Kahn of Philadelphia, and a panel of other architects and lighting consultants.

Lighting Contest Sponsored For Electrical Contractors

A competition for the best lighting installation initiated and completed by an electrical contractor between January 1, 1952 and August 1, 1953 is being sponsored by *Electrical Construction and Maintenance*, a McGraw-Hill publication. Prizes totaling over $1,000 will be given to first, second and third place winners in each of six classifications.

A contractor or full time employee of a contractor can enter in the contest an installation of any size covering one or more of the following: a lighting technique for a single specific visual requirement; a lighting installation for a specific area, large or small; an overall installation for an entire building or general area.

Prizes of $100, $50 and $25 will be awarded in the following classifications:

Stores (all interior sales areas).
Schools and offices (classrooms, private and general offices, drafting rooms, etc.).
Industrial areas (factories, warehouses, production and assembly areas, yard lighting, protective lighting, storage).
Residential (entire house or any parts thereof, including exterior and garden lighting).
Floodlighting (monumental, recreational, spectacular and utilitarian).
Miscellaneous (banks, museums, libraries, hospitals, hotels, churches, theaters, restaurants, auditoriums, gymnasiums, lobbies, reception rooms, etc.).

Entries will be judged by a board of five, with Carl W. Zerse, managing director, Chicago Lighting Institute, as Chairman. Other members are E. M. Strong, professor of electrical engineering, Cornell University, and I.E.S. President; J. S. Schuchert, commercial sales manager, Duquesne Light Co.; Richard Kelly, lighting consultant, and Willard W. Thompson, consulting electrical engineer.

Purpose of the contest, according to W. W. Garey, publisher of the magazine, is "to encourage, and to extend public industry recognition to electrical contractors and their employees who initiate, sell and install outstanding lighting installations, and to further the dissemination of meritorious lighting information." The magazine will publish a special Lighting Competition Issue in the Fall, featuring the six first prize winners. Second and third prize entries will be published later.

Change in Regional Conference

Pacific Northwest Regional Conference date and place have been changed since previous notices. This Conference is now scheduled to be held

April 2-3, 1953
Hotel Benson
Portland, Oregon

Pittsburgh Section Features "Quickie One-Night Reviews"

Continuing its training program for the year 1952-1953, the Pittsburgh Section held a "Quickie One-Night Review" of Fundamentals of Illumination on December 1 and December 8. Topics discussed at the December 1 meeting were:

Language of Lighting Practice.
Basic Lighting Objectives and Standards for Illumination and Brightness Ratios.
Light Sources and Lighting Equipment.
Lighting Design and Application Practices.

On December 8, the review covered "Recent Advances in Illumination" with the following topics discussed:

Reliable cost analysis methods of lighting equipment.
Recent developments in lamps and ballasts.
Group replacement in lighting maintenance.
Creating quality with availability.

Instructors for this review were: H. S. James, Duquesne Light Co.; A. Paulus, Westinghouse Electric Corp.; E. B. Colby, Sylvania Electric Products, Inc.; R. W. McKinley, Pittsburgh Corning Corp.; C. M. Crysler, General Electric Co.

A series of eight weekly meetings began January 5, with two hour sessions in a standard Fundamentals of Lighting Course, sponsored by the Section.

Eastern New York Chapter Gives Illumination Course

The new Eastern New York Chapter of I.E.S. last Fall sponsored a six session course on Fundamentals of Illumination, held at the Russell Sage Extension Division in Albany, New York. Topics covered in the 1½ hour meetings were:

Theory of Light and Control, Illumination Terms and Light Distribution Curves.
Filament, Electric Discharge and Fluorescent Lamps and Auxiliary Equipment.
Equipment Design — Fixture Design and Brightness and Glare Consideration.
Analysis of Lighting and Illumination Computations.
Lighting for Production, Lighting for Selling, Lighting for Seeing.
Economics of Lighting.

Registration fee for all six lectures was $7.50. Classes were held weekly from October 8 through November 12.

Lighting for Merchandising Conference in Chicago

As part of the Chicago Section's planned program for lighting education aimed specifically to those most directly affected, a "Lighting for Merchandising" Conference was held January 28 at the Chicago Lighting Institute. Co-sponsors with the I.E.S. and the Institute were eleven retail and merchants associations of Chicago.

The all-day conference featured eight top speakers on as many phases of store lighting. Chairman of the Conference was John W. Peterson, Manager of Lighting Sales, Graybar Electric Co., Chicago.

Leading off at nine in the morning with an Address of Welcome, was Carl W. Zersen, Manager of the Chicago Lighting Institute. Following him were:

Let There Be Light, by Joseph T. Meek, President, Illinois Federation of Retail Associations.
Lighting Tools for Merchandising, by R. G. Slauer, Manager, Applications Laboratory, Sylvania Electric Products, Salem, Mass.
Merchandising with Color, by Harper Richards, Industrial Designer, Chicago.
Lighting for Outside Store Areas, by J. E. Tewart, Lighting Engineer, Westinghouse Electric Corporation, Chicago.
General Lighting for Merchandising, by John S. Frizzel, Illuminating Engineer, Pittsburgh Reflector Company, Pittsburgh, Pa.
Supplementary Lighting, by E. F. McDonnell, Jr., Lighting Engineer, Commonwealth Edison Company, Chicago.
Window Display Lighting, by A. A. Sobolik, Jr., Lighting Engineer, Public Service Co. of Northern Illinois, Chicago.
And There Was Light, by Mrs. Rose Marie Siefer, National Association of Retail Grocers, Chicago.

LIGHTING CALENDAR

Society Events

February 12, 1953—Meeting of I.E.S. Council, New York, N. Y.

March 23-24, 1953—Canadian Regional Conference, Chateau Laurier, Ottawa, Ont.

April 2-3, 1953—Pacific Northwest Regional Conference, Hotel Benson, Portland, Ore.

April 9-10, 1953—South Pacific Coast Regional Conference, Los Angeles, Calif.

April 12-14, 1953 — Southwestern Regional Conference, Hotel Baker, Dallas, Texas.

April 13, 1953 — Meeting of I.E.S. Council, Dallas, Texas.

April 30 - May 1, 1953 — Midwestern Regional Conference, Hotel Radisson, Minneapolis, Minn.

May 14-15, 1953 — East Central Regional Conference, Hotel Lord Baltimore, Baltimore, Md.

May 18-19, 1953 — Southern Regional Conference, Sedgefield Inn, Greensboro, N. C.

May 25-26, 1953 — Great Lakes Regional Conference, Syracuse Hotel, Syracuse, N. Y.

September 14-18, 1953 — Illuminating Engineering Society, National Technical Conference, Commodore Hotel, New York, N. Y.

Industry Events

March 9-12, 1953 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

March 30 - April 2, 1953 — Annual Sales Conference, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.

April 27 - May 1, 1953 — Society of Motion Picture and Television Engineers, Hotel Statler, Los Angeles, Calif. Semi-Annual Convention.

April 13-14, 1953 — Annual Convention of the Electrical Contractors Association of Ontario, Royal Connaugh Hotel, Hamilton, Ont.

April 28-30, 1953 — The American Society of Mechanical Engineers (Spring Meeting), Deshler-Wallick Hotel, Columbus, Ohio.

May 7-8, 1953 — Public Utilities Advertising Association, Annual Convention, Hotel Chase, St. Louis, Mo.

May 18-22, 1953 — National Materials Handling Exposition, Convention Hall, Philadelphia, Pa.

May 24-28, 1953 — National Association of Electrical Distributors, 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.

June 1-4, 1953 — 21st Annual Convention, Edison Electric Institute, Atlantic City, N. J.

June 9-12, 1953 — Store Modernization Institute, Fourth Annual Modernization Show, Madison Square Garden, New York, N. Y.

June 28 - July 2, 1953 — American Society of Mechanical Engineers, Semi-Annual Meeting, Statler Hotel, Los Angeles, Calif.

June 29 - July 3, 1953 — Summer General Meeting, American Institute of Electrical Engineers, Atlantic City, N. J.

August 18-21, 1953 — Pacific General Meeting, American Institute of Electrical Engineers, Vancouver, B. C.

September 21-26, 1953 — 25th Jubilee Meeting, International Association of Electrical Inspectors, Edgewater Beach Hotel, Chicago, Ill.

September 23-25, 1953 — Annual Meeting, Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont.

October 5-9, 1953 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y. Semi-Annual Convention.

October 19-21, 1953 — American Standards Association, 35th Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 19-23, 1953 — 41st National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 9-12, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 17-19, 1953 — National Electrical Contractors Association, Miami Beach, Fla.

November 29 - December 4, 1953 — The American Society of Mechanical Engineers (Annual Meeting), Statler Hotel, New York, N. Y.

January 18-22, 1954 — Winter General Meeting, American Institute of Electrical Engineers, New York, N. Y.

March 8-11, 1954 — National Electrical Manufacturers Association, Edgewatar Beach Hotel, Chicago, Ill.

Here and There with I.E.S. Members

Indoctrination meeting was held for officers of the Sections and Chapters comprising the Northeastern Region, called by Regional V-P G. J. Taylor, December 12 at the Hotel Biltmore in New York. Left to right, around table, are M. N. Waterman, Chairman, New York Section; E. A. Fahey, Secretary, New York Section; Francis Clarke, Chairman, Connecticut Section; Vice-President Taylor; C. C. Keller, General Secretary; B. G. Slauer, Past Regional V-P; Lawrence Cooke, Chairman, New England Section; H. R. Finney, Secretary, New England Section and A. D. Hinckley, Executive Secretary.

Panel board discussion on "Lighting for St. Louis" was one feature of the highly successful meeting of the St. Louis Section, December 11. With M. E. Skinner as Moderator are the panel members, left to right: L. E. Barrett, speaking for the Distributor K. E. Wischmeyer, speaking for the Architect; Moderator Skinner; E. W. Voepel, speaking for the Engineer; and R. W. Osborn, speaking for the Electrical Contractor. A special presentation, by Dr. Edgar C. Taylor, on "The Emotional and Religious Aspects of Lighting at Christmas" was greatly praised by the audience of over 250.

Joint I.E.S. meeting of the Twin City Section and the Winnipeg Chapter was held recently in Winnipeg. Shown is the welcoming luncheon sponsored by the Canadian hosts. Joint affair included a tour of installations in Winnipeg and an evening session featuring Professor Russell, School of Architecture, University of Manitoba.

One-night "Quickie" reviews on Fundamentals of Illumination and Recent Advances in Illumination were held by the Pittsburgh Section of I.E.S. December 1 and 8. See story on page 7A.

The Southern California Section voted as a huge success the "Ladies Night" meeting December 3, planning to make it an annual event. The attendance of over 200 heard A. A. Reitman speak on residential lighting. Music was provided by Jose Arias Troubadours, of 1950 Conference fame. Special certificates for meritorious service were awarded to Hobart M. Thatcher and to Judson M. Hawthorne.

Testimonial dinner for John D. Henninger, second from right at head table, was given by the Wyoming Valley Better Lighting Club of the Eastern Pennsylvania Section, December 6 in Wilkes-Barre. Mr. Henninger, member of the Society for 42 years, is retiring from the General Electric Company after continuous service since 1909.

Some of the 40 members and guests who attended the Charter meeting of the San Jose (California) Chapter I.E.S. which was held at the Hawaiian Gardens in San Jose last November.

Eastern New York Chapter in Albany, N. Y., receives official Charter and, as a gift from New Mexico Chapter, an historic gavel. Shown presenting the Charter to Chairman C. E. Waldron (right) is I.E.S. President, E. M. Strong.

Street Lighting Committee To Hold Conference in Atlanta

The I.E.S. Street and Highway Lighting Committee will hold its semi-annual meeting in Atlanta, March 26 and 27. The two-day conference, scheduled for the Ansley Hotel there, will be attended by about 42 members of the committee. An inspection tour of Atlanta's progressive street lighting system has been arranged for the evening of March 26. Francis D. Wyatt, Chicago Park District, Chairman of the Street and Highway Lighting Committee, and Jack Murrah, Georgia Power Co., are in charge of the arrangements.

Indiana Chapter Plugs I.E.S. On T-V Programs

The Illuminating Engineering Society, its purpose and achievements, was the subject of a television program sponsored by the Indiana Chapter November 7 in Indianapolis. Arranged by Ed Chelew and Denton Hall, Chapter members, the program summarized briefly the make-up of the Society, and with posters announcing the meeting programs for the year.

Also on television, November 6, was a question and answer period by W. W. Brooks, Ballast Engineering Division of General Electric, in which he answered questions on that company's new lamp and ballast.

Small Business Counsel Established

Counseling on Navy procurement has been established for small business in all Small Defense Plants Administration regional offices. All technical information concerning procurements, invitations for bids, requests for proposal and bid forms, surveys, lists and other information of value to small business will be the mission of the Navy Industry Cooperation Officer in the thirteen S.D.P.A. offices.

Western Manufacturers Organize Lighting Institute

West Coast manufacturers of industrial and commercial lighting units met recently to form the Western Lighting Manufacturers Institute. Organization headquarters will be in Beverly Hills.

Phillip Freeman, Sunbeam Lighting Co., Los Angeles was elected president; Leonard Rosenblatt, Globe Lighting Products, vice president; Joseph Marx, Nu-Lite Fluorescent Mfg. Co., secretary-treasurer, and Stanley Lindahl, Light Control Co., chairman of the membership committee. According to Mr. Freeman, the Institute's activities will include: lighting information projects related to industrial production and workers' vision; research on industrial and commercial lighting needs and problems; employee and government relations, and facilities for rating lighting products manufactured in the West.

Eastern New York Chapter Holds Charter Meeting

The official Charter Meeting of the Eastern New York Chapter (Albany) was held November 24, 1952, at the Crossroads Restaurant, Latham, N. Y. This was a sort of "second ceremony" for this active group, since their officers were present to receive a first copy of their charter at the Council meeting which approved it, last June in Swampscott, Mass.

Official presentation was made by I.E.S. President, Prof. E. M. Strong, who also presented to the new chapter, an official gavel which was a gift from the New Mexico Chapter. The gavel was specially made, of a most unusual design. The wood is from native cedar, supplied by the Department of Anthropology of New Mexico, taken from an old Indian pueblo building existing some time between the years 1350 and 1550 A.D. A modern touch is supplied by a piece of trinitite embedded in clear plastic in the head of the gavel. Trinitite is formed by the fusion of white sand at the first atomic explosion at White Sands, New Mexico.

Both Charter and gavel were proudly received for the Chapter, by Chairman C. E. Waldron.

GAVEL presented to the Eastern New York Chapter is made of native (to New Mexico) cedar, supplied by the state Department of Anthropology, taken from an old Indian pueblo building and a piece of trinitite — formed from the first atomic explosion.

Northeastern Region Officers Hold Indoctrination Meeting

An all-day meeting designed to correlate Section and Chapter activities with overall Society operation, was held December 12, by officers of the Sections and Chapters comprising the Northeastern Region of I.E.S. George J. Taylor, Regional V.P., presided.

In addition to detailed discussions on Section plans, the local officers had a valuable "briefing" on national and headquarters operation from Clarence C. Keller, national General Secretary, A. Dexter Hinckley, Executive Secretary, and Ruby Redford, Editor of I.E.

The very thorough agenda included:

Selection of Regional Nominating Committee
Section and Chapter Budgets
Nominations for Fellow
Regional Conferences
New York Technical Conference
Extension Meetings — Local Representatives
Local Meetings, Programs and Notices
My Most Interesting Lighting Job Contest
Conference Display Board
Data Sheets
Membership Committee
Sustaining Membership
Members in Armed Services
Public Relations and Information

Attending the meeting were: G. J. Taylor, Regional V.P., Marshall Waterman, Chairman of the New York Section and Eugene Fahey, Secretary; Francis Clarke, Chairman Connecticut Section; Lawrence Cooke, Chairman New England Section, and H. R. Finney, Secretary.

These Sections Had a Good Idea

Three or four "good ideas," unusual or especially successful local projects, undertaken by I.E.S. Sections or Chapters will be outlined here each month. — Ed.

1. **Toronto Section** staged a "Young Members Night" February 2, at which members under 35 years of age presented papers, in competition with one another. Cash prizes of $10.00 were awarded for the best technical paper and for the best presentation of a paper.

2. **Oregon Section** held a Past-Chairman's Day December 10, honoring all their past officers. Walter J. Lind, their Regional V.P., paid an official visit at the same time.

3. **Eastern Pennsylvania Section** lists all its Local Representatives on its regular meeting notice. Further bringing these important members into the picture, they schedule each of their meetings in a different town, the Local Rep handling all details.

4. **Pittsburgh Section** Data Sheet Re-

(Continued on page 13A)

WHY ...are More and More...

MANUFACTURERS

ARCHITECTS

ENGINEERS

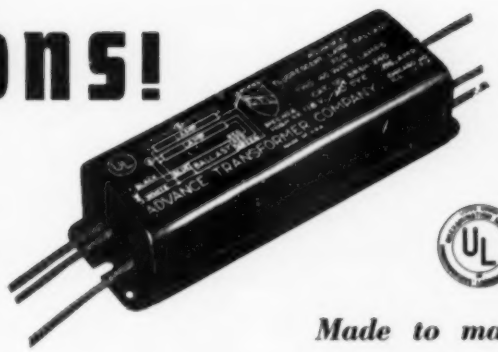
WHOLESALERS

CONTRACTORS

Demanding

ADVANCE BALLASTS

BIG REASONS!



CERTIFIED E·T·L

UL

Less than one and one half tenths of one percent rejects.

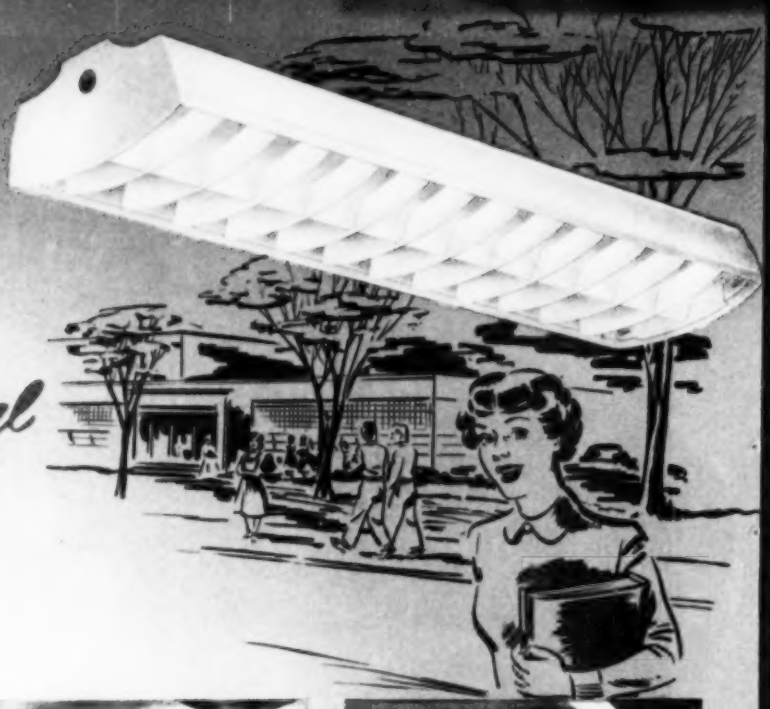
Made to maintain the lowest noise level of any fluorescent ballast on the market.

The Best Ballast Buy

CABLE ADDRESS: ADTRANS

1122 W. CATALPA AVE., CHICAGO 40, ILL., U.S.A.

Reavis High School chooses *Leader*



Leader fine lighting for schools is exemplified by the installations made in the recently completed Reavis High School, Oak Lawn, Illinois. Leader fixtures are completely "at home" in these school interiors which embody the latest ideas in modern design. The VARSITY, a luxury fixture at a budget price... the OFFICER, outstanding for efficiency and beauty . . . the CORRI-LITE, unique for attractive lighting of corridors . . . these are some of the Leader units chosen for this beautiful new high school building.

Classroom — Leader VARSITY

Office — Leader OFFICER

Library — Leader VARSITY

Corridor — Leader CORRI-LITE

Home Economics Kitchens — Leader OFFICER

Check the details on these fine LEADER fixtures:

- **VARSITY (shown above) — Steel channel, baffle-type steel louvers. Choice of steel or plastic side panels. 25°-35° shielding (other shielding angles on request). For 2 lamps, in choice of 48", 72" or 96" length.**
- **OFFICER — Steel channel, curved translucent plastic side panels. 40° x 40° shielding provided by injection moulded plastic louver. For 2, 3 or 4 lamps, in lengths from 48" to 96".**
- **CORRI-LITE — Channel and unusual style baffles of steel. For single Slimline lamp in 48", 72" or 96" length.**

There's a Leader lighting unit for every school need . . . scientifically designed to provide abundant light output, correct shielding, ease and flexibility of installation, economy of first cost and maintenance. If you have school lighting problems, either in new construction or in remodeling, look to Leader for the best solution.

Sold and installed by the better electrical wholesalers and contractors

Leader *America's No. 1 Lighting Equipment Manufacturer*

LEADER ELECTRIC COMPANY • 3500 North Kedzie Avenue • Chicago 18, Illinois

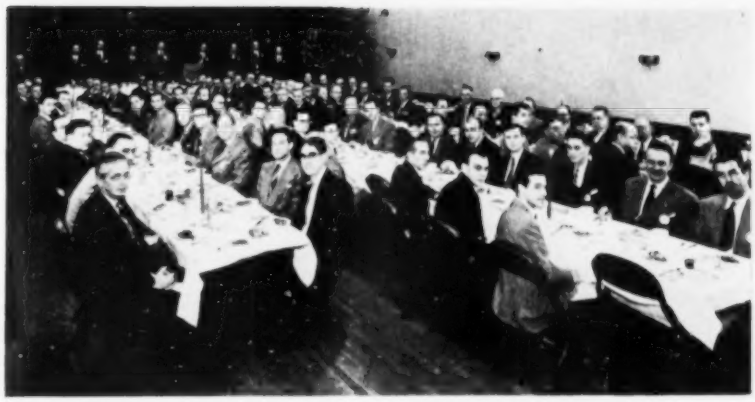
Leader Electric — Western • 800 One Hundredth Avenue • Oakland 3, California

Campbell-Leader, Ltd. • Brantford, Ontario • Canada

(Continued from page 10A)

porter (A. G. "Cappie" Caplan) sends out special notices to all Pittsburgh members listing the type of installations most needed for official I.E.S. Data Sheets. Pays off too, with more Pittsburgh lighting installations now being considered by the national Technical Data Sheet Sub-Committee than from any other part of the country.

5. **Cleveland Section** early in the season, sent all members a wallet sized folder which lists dates, places and subjects for the entire year's meetings. It even includes a list of all officers and committee chairmen, and a 1952-1953 calendar with meeting dates circled. Photo offset reduction brings it down to 2¼" by 3¾", fitting in wallet, *easy*.



ONE of the "must" meetings for the Pittsburgh Section each year was held on December 15. This is the joint meeting with the Western Pennsylvania Chapter of the National Electrical Contractor Association. The meeting provides an opportunity for both groups of the electrical industry to discuss their common problems, and come to a clear and sympathetic understanding of individual problems. The speaker at this meeting was George B. Roscoe, Director of Public Relations of N.E.C.A., who spoke on "Inter-Dependency in the Electrical Industry."

Co-Op Training Program Started At Fort Belvoir Laboratories

Relations between private education and public service were welded more firmly by a Cooperative Training Program by the Virginia Polytechnic Institute, Blacksburg, Va., and the U. S. Army's Engineer Research and Development Laboratories, Fort Belvoir, Va.

Eight student engineers, from sophomore to senior level, began a six month cooperative training program at the Engineer Research Labs, on December 22. The Cooperative Training Program, for the first time instituted at Fort Belvoir, is designed to include twenty pairs of students seeking degrees either in Physics or Engineering. To be included at a later date are students from the Drexel Institute of Philadelphia, a school whose curriculum is based solely on the principle of cooperative training.

The eight V.P.I. students will be assigned appropriate positions in accordance with their present level in school. Their pay scales will depend upon their education and experience according to Civil Service requirements. The students will be housed on the Post in dormitories and will be subject to the same regulations affecting other civil servants.

Although this is the first six month assignment for these students, they will be returning to the Engineer Labs for further training until graduation.

Philadelphia Section Tours Country In Joint Meeting with Architects

A tour of the country by film on the subject of Commercial Lighting was a feature of the January 6 meeting of the Philadelphia Section, I.E.S. Participating as both narrators and audience were members of the Philadelphia Chapter of the American Institute of Architects.

Featured in the illustrated tour were outstanding store, bank, public building and exterior installations gathered from the four corners of the United States. Narrators, who pointed out the "good" and "bad" features of the installations, were C. C. Zantzinger, Jr., Kneedler, Mirick & Zantzinger; H. Mather Lippincott, T Square Atelier; C. C. Shotwell, Philadelphia Electric Co.

Occupation Breakdown Of I.E.S. Members

The Publications Office at headquarters has underway the compilation of a breakdown by occupation, of I.E.S. members. These figures are being obtained through the cooperation of the secretaries of the Society's 61 Sections and Chapters. To date 31 Sections and Chapters, representing 3809 members of I.E.S. have supplied breakdown figures for the survey, and it is hoped that the remaining Sections will complete their compilation shortly.

In this connection, it is interesting to note that the Southern California Section makes an annual check of all members in relation to their occupation, and has this constantly available.

I.E.S. Regional Conferences, 1953

Canadian	Chateau Laurier Ottawa, Ont.	March 23-24
Pacific Northwest	Hotel Benson Portland, Ore.	April 2-3
South Pacific Coast	Los Angeles, Calif.	April 9-10
Southwestern	Hotel Baker Dallas, Tex.	April 12-14
Midwestern	Radisson Hotel Minneapolis, Minn.	April 30 - May 1
East Central	Hotel Lord Baltimore Baltimore, Md.	May 14-15
Southern	Sedgefield Inn Greensboro, N. C.	May 18-19
Great Lakes	Syracuse Hotel Syracuse, N. Y.	May 25-26

BUSINESS UP, ACCIDENTS DOWN Businessmen say relighting brought window-shopping crowds, encouraged new enterprises. Relighting cut traffic accidents 35% in only a few years — a tremendous economic saving, since studies show each traffic fatality means a loss of $65,000.

WELL-LIGHTED STREETS PAY

One thousand miles of new street lighting

MAYOR T. A. BURKE, a strong advocate of good street lighting, actively promoted Cleveland's relighting program.

"Cleveland saves with light. It has saved itself hundreds of lives, untold thousands of dollars worth of property, and millions in accident and crime prevention since we started our 'Relighting Cleveland' program in 1946," says Mayor Thomas A. Burke.

The birthplace of street lighting in 1879, Cleveland today lays claim to being the best-lighted city of its size in the world, and one of the safest.

In just six years, Greater Cleveland has gained over 1000 miles of well-lighted streets, of which 500 miles are in the city. This program is continuing.

Working hand-in-hand, the Cleveland Electric Illuminating Co. and the City of Cleveland are installing at least 100 additional miles of new lights each year.

They are backed by an enthusiastic public which endorsed a bond issue with a whopping 74 percent majority. The reasons for such support are told in the picture story on these pages.

G-E LIGHTING ENGINEERING is helping to relight thousands of miles of streets all over America, making communities safer, more pleasant places to live.

TRAFFIC ACCIDENTS awakened the public to the need for better lighting. This driver, a young doctor, was killed when his car ran through a barricade into a river at the end of a poorly lighted street.

CLEVELAND'S RELIGHTING was carefully planned by officials of the City's Division of Light & Power, Bureau of Street Lighting, the Cleveland Electric Illuminating Co., and General Electric engineers.

BEFORE RELIGHTING, many of Cleveland's darker streets were unsafe for women and children, pedestrians and drivers. Crimes and accidents occurred frequently in poorly lighted areas like this warehouse district.

AFTER RELIGHTING, the same street looked like this. Burglaries and attacks are a thing of the past, and the danger of traffic accidents is greatly reduced. Cleveland's citizens feel safer walking after dark.

OFF FOR CLEVELAND

saves lives, property and money

Your electric utility can call on General Electric's services for planning and consultation, just as Cleveland's utility has done. Vitally interested in your community's welfare, your utility has the know-how to help you modernize your street lighting quickly and economically.

If you would like our booklets on how to plan and promote new street lighting in your community, write Section 452-130, General Electric Co., Schenectady 5, N. Y.

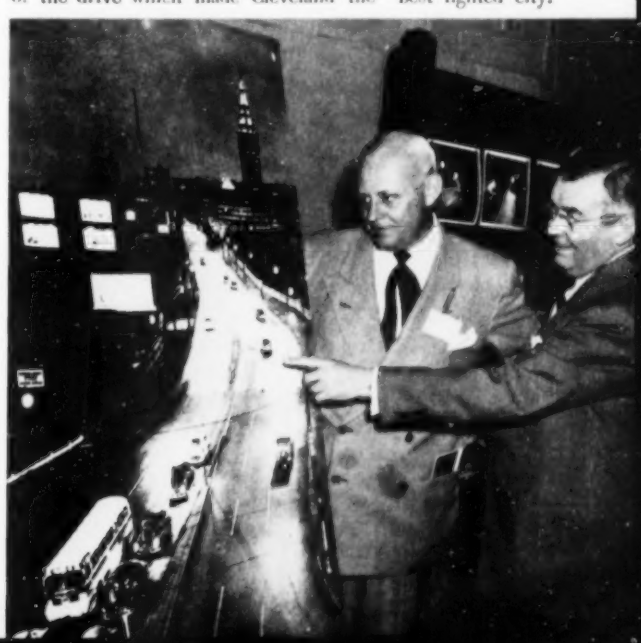
You can put your confidence in—

GENERAL ELECTRIC

"CASUALTYWAYS," Cleveland's term for streets with high accident rates, and "fearways," dark crime-ridden streets, were given top priority. Here, a workman is installing a modern General Electric street light.

TRAFFIC moves quickly and safely along well-lighted streets. Cleveland police and fire departments have found they do better jobs—fewer calls, and they arrive sooner when needed.

E. L. LINDSETH, President of Cleveland Electric Illuminating Co. and Mayor Burke were widely acclaimed for their spearheading of the drive which made Cleveland the "best lighted city."



S. K. Guth Receives Degree of Doctor of Ocular Science

Sylvester K. Guth, in charge of lighting research activities for General Electric's Lamp Division, Nela Park, Cleveland, received the honorary degree of Doctor of Ocular Science on January 25. The degree, one of two conferred this year by Northern Illinois College of Optometry at its 107th annual convocation in Chicago, is "in recognition of Guth's outstanding contributions to the profession of optometry."

Dr. Guth, according to NICO's announcement, "having taken part in numerous education seminars and optometric programs, has brought about better cooperation between the ophthalmic professions and illuminating engineering groups. His research in lighting as it affects seeing has been significant. Public relations with educators and optometrists, as practiced by Dr. Guth, has created a mutual respect and intelligent comprehension by both groups."

A graduate of the University of Wisconsin, Dr. Guth joined the Lamp Division of G. E. at Nela Park in 1930. During the past 20 years, he conducted many researches in the fields of light, vision, and seeing, developing many of the criteria and techniques used in evaluating visibility, contrast sensitivity, visual acuity, and ease of seeing.

Sylvester K. Guth

During his four years in the U. S. Army in World War II, Dr. Guth helped develop a wide variety of electrical and electronic devices designed for special viewing needs, for mine detection and the like. At the time of his discharge from active duty, he held the rank of major.

He is widely known for his lectures as well as his scientific and technical papers dealing with light, vision, and seeing. In the summer of 1951, he was named an American delegate to the meeting of the Commission Internationale d'Eclairage in Stockholm, presenting a paper at that convention on his latest findings in the matter of discomfort glare.

Be It Resolved

that the National Council of the Illuminating Engineering Society record sincere regret at the passing on December 9 of our Member Emeritus and Charter Member Samuel E. Doane, President of the Society in 1919-1920. Long associated with the General Electric Company, he was chief engineer of the Lamp Works at Nela Park, Cleveland, from which position he retired in 1930.

Under his leadership the Engineering Department and Lighting Institute at Nela Park achieved international prestige. Mr. Doane inaugurated a notably constructive program of activities which profoundly affected the progress of the lighting industry. Among these were the development of basic knowledge of lighting requirements and the technology of application, and publication of the pioneer technical bulletins on lamps and lighting, which were widely disseminated among those engaged in establishing lighting practice in this country. He was a leader in furthering the production of light on a sound economic basis, and in the standardization of bases and sockets.

Honored in 1927 when he received an Honorary Degree in Electrical Engineering from the Case Institute of Applied Science, he was highly esteemed both in this country and in Europe for his zealous efforts to spread to the entire world the good word of better lighting.

ABOUT PEOPLE

Edward C. Huerkamp, manager of the application engineering department of Westinghouse Electric Corp.'s Lighting Division, has been named chairman of the executive committee of the National Street and Traffic Lighting Safety Bureau. Mr. Huerkamp succeeds **A. F. Dickerson,** who had been chairman of the executive committee since its organization eight years ago.

T. J. Marshall and **K. W. Macdonald** have been appointed district representatives for General Electric's Construction Materials division, with offices in Chicago and Cleveland, respectively.

Sylvania Electric Products, Inc., has announced the appointment of **Arthur L. Chapman** to the newly created post of vice-president in charge of electronics operations. Mr. Chapman has been with the company since 1933 and has been a vice-president for the past two years.

F. J. Vorlander has joined Luminous Ceilings, Inc., as eastern manager of sales and engineering operations, with offices in the Little Building, Boston, Mass. Mr. Vorlander was formerly manager of commercial engineering for Champion Lamp Works.

Everett N. McDonnell, president of McDonnell & Miller, Inc., Chicago, has received the 1952 F. Paul Anderson Medal of the American Society of Heating and Ventilating Engineers "for outstanding work in the field of heating, ventilating and air-conditioning." Presentation of the award was made at the society's annual meeting in Chicago, January 28.

Champion Lamp Works, Lynn, Mass., announces the appointment of **Carleton M. Holden** as manager of their Commercial Engineering Department, of which he has been a member for several years.

R. W. Ahlquist has been appointed Chairman of the Electrical Engineering Department at the University of Detroit. Professor Ahlquist is the author of a recent textbook on electrical engineering.

William G. Darley, lighting consultant and I.E.S. Fellow, has been elected President of the Travis Chapter of the Texas Society of Professional Engineers for the 1953 term.

(Continued on page 19A)

BENJAMIN "Magna-Flo" Systems Excel!

that's why Overall Lighting Costs are LOWER!

Because Benjamin "Magna-Flo" Systems excel by every Quality Standard—lighting, electrical and constructional—they can provide high illumination levels at low overall lighting cost. Such cost involves more than the original price of the units. Overall lighting cost also includes the costs of installation, operation, maintenance and replacement. Add them all up and see why you're ahead with "Magna-Flo" Systems (individual unit or continuous line)—because "Magna-Flo" excels by ALL QUALITY STANDARDS!

This chart gives some of the important reasons why:

"MAGNA-FLO" CUTS INSTALLATION COST	"MAGNA-FLO" CUTS MAINTENANCE COST	"MAGNA-FLO" CUTS OPERATION COST	"MAGNA-FLO" CUTS REPLACEMENT COST
wide variety of knockouts facilitate wire entrances into unit.	Porcelain Enamel reflecting surface is easy to keep clean with soap and water.	made for efficient utilization of high light output T12 Slimline lamps.	famous Benjamin "built-like-a-battleship" construction of heavy gauge steel.
complete line of sliding hangers.	exclusive "Springlox" lampholders make possible "quick-in, quick-out" lamp maintenance.	high power-factor HL-approved ballasts for continuously-cool, efficient operation.	rigid channels and reflectors withstand toughest industrial vibration.
single, rugged channel coupling for continuous mounting.	Speedy, exclusive "Lok-Latch" reflector fasteners.	high reflection factor remains constant because genuine Porcelain Enameled reflector does not discolor or become dull with age.	"86" reflectors are made in two sections, kept perfectly aligned by positive alignment clips.

FREE Bulletin AD-5705 brings you complete specifications on Benjamin "Magna-Flo" Lighting Systems—famous for "Task-Matched" Lighting Installations.
Benjamin Electric Mfg. Co., Dept. I, Des Plaines, Ill.

Benjamin "Magna-Flo" Systems are Sold Exclusively through Electrical Distributors

BENJAMIN

To enhance its CENTURY OLD Beauty

THE BERLIN
CONGREGATIONAL CHURCH
IN BERLIN, CONNECTICUT

CHOSE

POWERSTAT

Light Dimming Equipment

WITH CONVENIENT
MULTI-STATION
REMOTE CONTROL

The simple, forthright beauty of this more-than-a-century-old house of worship is greatly enhanced by effective light control. By providing smooth, stepless dimming and brightening of light, much is contributed to the atmosphere of dignity and reverence.

The choice of a Motor-Driven POWERSTAT Dimmer offers maximum convenience in operation. Simple raise-lower switches in the pulpit, at the organ and in the rear of the church allow complete control of the entire lighting system from any of these three stations. The dimmer unit is unobtrusively located in the cellar.

There is a POWERSTAT Dimmer just right for every requirement . . . simply and easily installed in new or existing circuits. Get complete information now; use the handy attached coupon to send for literature on POWERSTAT light dimming equipment.

5023 DEMERS AVENUE, BRISTOL, CONN.

Please send literature on POWERSTAT light dimming equipment.

NAME_____

POSITION_____

COMPANY_____

CO. ADDRESS_____

CITY_____ ZONE____ STATE____

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

(Continued from page 16A)

Charles F. Johnson, with Curtis Lighting, Inc., for about forty years, has retired from that company, continuing to serve the lighting industry as a consultant.

Chemical Development Corp., Danvers, Mass., plastics manufacturers, have established a sales office at 366 Madison Ave., New York, N. Y. **Ross F. Rathbun,** who has had many years of experience in the plastics field, will be in charge of all sales in the metropolitan area.

Chester S. Shaffer, formerly with the Department of Streets and Electricity of the City of Chicago, has joined E. I. du Pont de Nemours as an engineer on the Savannah River Project of the Atomic Energy Commission. His present address is 42 Peachtree Gardens, Barnwell, S. C.

Oscar W. Meissner has accepted the position as Street Lighting Engineer with the Bureau of Street Lighting, City of Los Angeles. Mr. Meissner was formerly with the Illuminating Engineering Unit, Department of Water and Power in the same city.

IT SEEMS TO ME

Light Depreciation Survey

The report by V. L. Dzwonczyk, page 430, ILLUMINATING ENGINEERING, August 1952, covering depreciation of 20 different luminaires in wide range of use in a Roanoke, Va. office building indicates real effort to get at long sought after facts. To me it could have been more helpful if quality as well as intensity had been considered. A level of 35 to 73 foot candles at various places in the interior indicates a building that would seem to have enough light for the type of work being done, but quantity is not a guarantee of comfortable efficient seeing, some of it highly critical according to Mr. Dzwonczyk's Table I showing types of offices.

In making a survey I have always felt that stations should be selected which will not penalize any type of luminaire. Mr. Dzwonczyk would know whether Table I, showing tests points, applied to all offices and the varying types of luminaires. If so, it could have penalized some luminaires with a strong indirect component since the Weston 603 meter is not cosine corrected.

Another factor which experience has pointed up for me is the necessity to check lumen output in advance. The surveys started two months after the building was occupied, and the last test was more than a year later. The drop of about 20 per cent in illumination over 14½ months could have been largely a drop in lumen output rather than dirt, or lumens plus dirt.

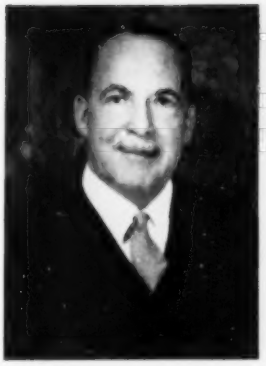
By determining the average output from each lamp at each of the (three) tests it could be subtracted from the total depreciation leaving the actual depreciation from soiling not only on the luminaires but on wall and ceiling surfaces. They too are a part of the "lighting system."

Mr. Dzwonczyk's work verifies what has been found in tests at Case Institute of Technology, that an air-conditioned room is not necessarily a clean room. Much dirt comes in when doors are opened, it is carried on clothing, particularly shoes, and of course an open window is an invitation to more of the same.

This being true, the pithy comment of Harold B. Gores, Superintendent of Schools, Newton, Mass. (ILLUMINATING ENGINEERING, April 1950, page 241) should be in mind when we are considering Quality and Cost along with the Quantity of light for a purchaser. He said: "It costs more to maintain something than not to maintain it . . . compared with the cost of maintaining the ceilings, walls, floors and other surfaces, the cost of cleaning (even) luminous shields is negligible." He added that the cost looms large only if it is the *only* maintenance that is done. That last would not apply, of course, to the Roanoke office building under study. But, realistically, too many purchasers of lighting equipment fail to realize that not only the room but the entire environment must be maintained for the best results and economy of operation, like a car or truck.—R. D. BURNHAM, *F. W. Wakefield Brass Co., Vermilion, Ohio.*

OBITUARIES

Clarence L. Law, nineteenth President of the Illuminating Engineering Society, died December 24, at his home in Pelham, New York. Mr. Law's contributions to the lighting industry and to the Society were many, among them notably the establishment of liaison between electric utilities and the Society, at the time when education of the public was most urgently needed. During these early and formative years of I.E.S. Clarence Law was one of those who ably supplied the leadership to bend the Society in the direction of national service. During his term as President, 1923-1924, the I.E.S. and the National Electric Light Association sponsored a nation-wide Training Course in Lighting, of which he said in his Presidential Address: "This, we hope, is merely a first step in what should develop into a broad program of education in the principles and practices of Illuminating Engineering—an education both of those within the industry and the general public."



Clarence L. Law

Mr. Law had joined the Society in 1908, and served as Secretary and Acting Chairman of the New York Section; Vice-President for two years, General Secretary for five and Director for one. He was active on committee work and presented several papers before the Society.

Mr. Law's conviction for public education was carried into his business career, where his work, at Consolidated Edison in New York City, was in great part concerned with customer and public relations. In 1906, he first joined "Con Ed's" predecessor, the New York Edison Company, and in 1928 became general manager. In 1939 he was elected vice-president of Consolidated Edison, in charge of the company's editorial, advertising and economic research and industrial development departments, and the directing of relations with civic and industry associations. He personally held posts in many industry and civic organizations, among them: The Commerce and Industry Association; the Broadway, Fifth Avenue and First Avenue Associations; the Electrical and Gas Association of New York; the West Side Association of Commerce and the Greater New York Fund. On his retirement from active business in 1950, he was given one of the most sincere tributes of appreciation ever rendered one of the leaders in New York.

Clarence Law will always be remembered in the I.E.S. The Law Golf Trophy, eagerly fought for on the links at each National Technical Conference, was first presented by him at the Briarcliff Conference in 1924.

(Continued on page 20A)

(Continued from page 19A)

The Society also records with regret the death of **C. T. Roberts,** December 7. A charter member of the Maritime Chapter of I.E.S., and active in its formation as a Chapter, Mr. Roberts had been with the Northern Electric Co., Ltd., for 25 years and was a member of the Telephone Pioneers of America. He had served the Society as Secretary of his Chapter during 1951-1952.

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at Headquarters Office, Technical Dept.*

Photoelectric Tubes by A. Sommer, Second Edition published 1952 by Methuen & Co., Ltd., London (available in U. S. from John Wiley and Sons, New York); 136 4 x 6½ inch pages, 27 illustrations, 5 tables; price $1.90.

This English book describes theories of photoelectric emission, photoelectric cathodes, matching of light sources and photocathodes, vacuum photocells, gas filled photocells, multiplier photocells, and applications of photocells. A 69 item international bibliography is also included.

Questions and Answers about the RLM Label is an 8 page pocket size booklet published by the RLM Standards Institute. Written in the question and answer technique, this booklet answers some of the most frequently asked queries about the RLM Institute itself, the RLM label and the RLM certification procedure. Starting with a brief resume of the Institute's history and ending with a condensed list of the illuminating engineering factors involved in RLM specifications, the booklet covers such topics as:

What an RLM member manufacturer is pledged to do.
How the Institute goes about establishing a basis for its specifications.
Who does the actual inspection and certification of the lighting units.
What are some of the specific tests an RLM-certified unit must pass.
What are the benefits to the lighting equipment buyer which are assured by the RLM label.

The booklet is of interest to industrial executives, consulting engineers, purchasing agents, plant superintendents, maintenance chiefs, building managers, architects, utility lighting men, electrical contractors and wholesalers and all those concerned with industrial lighting. Copies may be obtained free by writing to RLM Standards Institute, Suite 818, 326 West Madison St., Chicago 6, Illinois.

Latest in a series of **"See Better-Work Better"** bulletins, designed to promote improved lighting in industrial plants, has been issued by General Electric's Lamp Division. The 8 page Bulletin No. 8, illustrated and in full color, describes industrial lighting based on the concept of balanced brightness as well as sufficient light over the entire work area. Headings of the bulletin's various sections are: "Here's What Is Happening to Industrial Lighting," "New Era in Lighting Fixtures," "Comfortable Working Environments Pay Off," "Another Look at the New Look," "The Revolution Applies to All Plant Areas." Single copies of Bulletin No. 8 are available, free, from the Inquiry Bureau, General Electric Co., Nela Park, Cleveland 12, Ohio.

A new booklet, **Your Home Lighting Idea Book,** 24 page pamphlet is available from the Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y. Offering practical suggestions for planning home lighting and providing lighting equipment information for the consumer, it has been prepared by the E.E.I. Residential Lighting Committee. Designed for present and prospective home owners, planners, and remodelers, the booklet illustrates and describes lighting ideas for the living, recreation, dining, bed and bath rooms and offers suggestions for entrances, kitchens, garages and workshops.

Newly revised edition of a 13-minute motion picture **Light Control Through Polarization** is available from the Polaroid Corporation, Cambridge 39, Mass. This new black and white version employs animation to diagram the nature of light and to show how Polaroid Filters work in controlling reflections and cloud contrast in photography, predicting the strength of mechanical structures, detecting strains in glassware and plastics, identifying crystals, sharpening vision in sports and military observation.

Sun Control & Daylighting, part 1 of a Technical Reference Guide, is published in the July-August 1952 issue of the Bulletin of the American Institute of Architects. This study is intended to acquaint architects with current research, organizations and institutions and specialists working on daylighting problems and some of their findings.

Here's How — a catalogue of proved accident prevention projects for traffic safety — contains 56 pages of ideas used by local, state and private groups. The booklet is available from the National Committee for Traffic Safety, 20 North Wacker Drive, Chicago, Ill.

NEW MEMBERS

At the meeting of the Council Executive Committee, held in New York City on January 9, the following were elected to membership:

ALAMO CHAPTER

Associate Member:
Martin, G. C., Jr., Texas Scenic Co., San Antonio, Texas.

BRITISH COLUMBIA SECTION

Associate Member:
Spencer, J. C., Canadian General Electric Co., Vancouver, B. C.

CAPITAL SECTION

Member:
Nickerson, Dorothy, U. S. Dept. of Agriculture, Washington, D. C.
Associate Member:
Maloomian, N. G., Curtis Lighting Inc., Silver Spring, Md.

CAROLINAS SECTION

Associate Members:
Buchan, B. F., Southern States Supply Co. Inc., Charlotte, N. C.
Phillips, A. H., Sullivan Hardware, Greenville, S. C.

CENTRAL ILLINOIS CHAPTER

Member:
Schaefer, George, J. C. Schaefer Electric Inc., Peoria, Ill.
Associate Members:
Howerton, H. E., Duro Test Corp., Peoria, Ill.
Jacob, J. G., J. G. Jacob & Sons Inc., Morton, Ill.
Jacob, J. E., J. G. Jacob & Sons Inc., Morton, Ill.
Jacob, Kenneth, J. G. Jacob & Sons Inc., Morton, Ill.
Tometich, W. H., Westinghouse Electric Corp., Peoria, Ill.
Young, Bud., 213 E. Franklin St., Peoria, Ill.

CENTRAL NEW YORK SECTION

Associate Member:
Markert, T. A., Graybar Electric Co., Syracuse, N. Y.

CHICAGO SECTION

Members:
Kaufman, Mort., House-O-Lite Corp., Chicago, Ill.
Simon, A. L., Garden City Plating & Mfg. Co., Chicago, Ill.
Associate Members:
Clennon, H. L., Clennon Electric Co., Wilmington, Ill.
Eaton, Herbert, General Electric Co., Chicago, Ill.
Harvey, L. R., Englewood Electric Supply, Rockford, Ill.
Horchner, R. S., Sylvania Electric Products Inc., Chicago, Ill.
Kennedy, M. J., Jr., Chicago Electrical Supply Co., Chicago, Ill.
Kremer, G. J., Westinghouse Electric Supply Co., Hammond, Ind.
McKee, W. H., Kopp Glass Inc., Oak Park, Ill.
Sorenson, H. T., General Electric Co., Chicago, Ill.
Stepanek, W. J., Sylvania Electric Products Inc., Chicago, Ill.
Wenholz, Walter, Dept. of Subways & Superhighways, City of Chicago, Chicago, Ill.

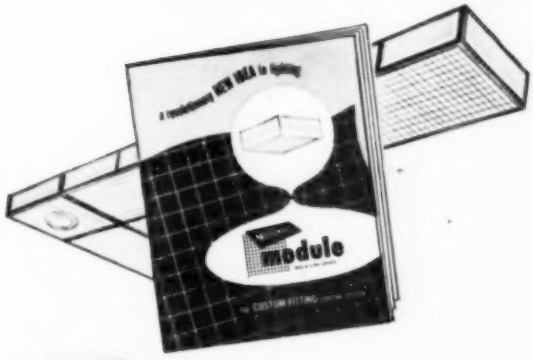
CONNECTICUT SECTION

Associate Members:
Diachenko, L. R., Graybar Electric Co., Inc., W. Hartford, Conn.
McCarthy, G. E., Graybar Electric Co., Hartford, Conn.
Sprankle, C. N., Plax Corp., Hartford, Conn.
Sullivan, D. E., Graybar Electric Co., Inc., West Hartford, Conn.
Student Member:
Malinguaggio, Paul, University of Connecticut, Storrs, Conn.

(Continued on page 38A)

easiest to specify, easiest to install, easiest to sell

America's most **complete** Quality Lighting Line



MITCHELL **module** CUSTOM-FITTING LIGHTING

The revolutionary lighting system for commercial interiors. Forms unlimited patterns—delivers 20% MORE LIGHT—installs quickly and economically—offers enduring beauty. Four basic "building blocks of light" CUSTOM-FIT any commercial interior at no more than the cost of ordinary fixtures. For full details, ask for **Catalogs No. 360 and No. 370.**

MITCHELL

COMMERCIAL FLUORESCENT LIGHTING

MITCHELL offers 70 superb Commercial Luminaires to meet the requirements of every conceivable installation: stores, offices, schools, institutions. You can specify MITCHELL Luminaires with confidence—they're tops for quality, time-saving installation, low-cost maintenance and lighting efficiency. **Ask for Catalog No. 433.**

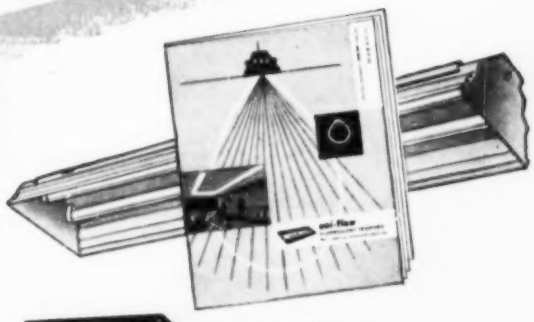
MITCHELL

EVERYTHING IN LIGHTING
FROM ONE DEPENDABLE SOURCE

MITCHELL **DYNALITE**

Job-rated Lighting for Industry

You'll find it easy to specify for any industrial application when you choose from the complete line of 82 DYNALITE units. Available in all lengths and lamp types, with choice of reflectors and shielding. There's a DYNALITE that's PRODUCTION-RIGHT for every job. Full details in **Catalog No. 438.**



MITCHELL ***uni-flow***

Fluorescent Recessed Lighting

Here's the latest and finest achievement in recessed lighting: 6 different troffer lengths (shallow or deep); 12 types of shielding; 7 types of lamps; choice of reflectors—PLUS exclusive ONE-MAN installation feature that cuts installing time by 50%! The complete facts are in **Catalog No. 605.**

It's easy to specify, easy to sell from MITCHELL'S "tell-all" Catalogs covering Everything in Lighting. Write for them today.

MITCHELL MANUFACTURING COMPANY
2525 N. Clybourn Ave., Chicago 14, Illinois
In Canada: Mitchell Mfg. Co., Ltd., 14 Waterman Ave., Toronto

ADDRESS DEPT. 3-B

SUSTAINING MEMBERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Advance Electrical Supply Co.
2033 W. Madison, Chicago, Ill. *Lee Butler*

Advance Transformer Company
1122 W. Catalpa Ave., Chicago 40, Ill. *A. E. Feinberg*

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave.,Chicago 18, Ill. *Max Klein*

Aluminum Company of America
Gulf Building, Pittsburgh 19, Pa. *C. Braglio*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada *W. A. Dalrymple*

American Concrete Corp.
5092 N. Kimberly Ave., Chicago 30, Ill. *J. W. Lewis*

American Fluorescent Corp.
1234 N. Paulina St., Chicago 22, Ill. *William Rusnak*

American Steel & Iron Works, Div. A. F. Anderson Iron Works
5801 S. Lowe Ave., Chicago 21, Ill. *Mahlon Brown*

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1729 Wellington Ave., Chicago 13, Ill. *Nils A. Tornblom*

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark. *Max Sudduth*

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio *George E. Glatthar*

Atlantic City Electric Co.
1600 Pacific Ave., Atlantic City, N. J. *John B. Taylor*

M. B. Austin Co.
1405 Shermer Ave., Northbrook, Ill. *James M. Collins*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *Benjamin S. Benson*

Blue Ridge Glass Corp.
P.O. Box 651, Kingsport, Tenn. *James Herbert*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570, Lansing 3, Mich. *John D. Mainight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Branham, Mareck & Duepner, Inc.
7020 Walker St., St. Louis Park, Minneapolis 16, Minn. *Cecil H. Branham*

Bright Light Reflector Co., Inc.
Fairfield & State, Bridgeport 5, Conn. *R. J. Mott*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St., Vancouver, B. C., Canada *H. N. Walters*

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *Robert W. Dowd*

Calpa Products Co.
5420-28 Paschall Ave., Philadelphia 4, Pa. *Paul C. Calissi*

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass. *Reginald H. Bowman*

Canadian General Elec. Co., Ltd.
212 King St., Toronto, Ont. *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada *L. E. Messinger*

Canadian National Exhibition Association
Exhibition Park, Toronto, Ont. *H. E. McCallum*

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
516 Jefferson Ave. S., Peoria 2, Ill. *W. F. Bolle*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Louisiana Electric Co., Inc.
P.O. Box 1096, Lafayette, La. *J. R. Gaugler*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas *James M. Williams*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio *J. R. Hartman*

City of Burbank, California Public Service Dept.
174 W. Magnolia Boulevard, Burbank, Calif. *J. H. McCambridge*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *L. W. Grayson*

City of Riverside Electric Light Dept.
P.O. Box 826, Riverside, Calif. *A. J. Kennedy*

City of Seattle, Dept. of Lighting
1015 Third Ave., Seattle 4, Wash. *P. C. Spowart*

City of Tacoma, Light Division
402 City Hall, Tacoma 2, Wash. *Roy H. Weston*

The Cleveland Electric Illuminating Co.
75 Public Square, Cleveland 1, Ohio *R. C. Hienton*

Clyde Porcelain Steel Corp.
2211 Birdseye St., Clyde, Ohio *W. F. White*

Colonial Premier Corp.
466 W. Superior St., Chicago 10, Ill. *Richard Weis*

Columbia Electric & Mfg. Co.
Box 2180, Spokane, Wash. *Walter A. Toly*

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill. *Michael R. Fine*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *Ralph G. Raymond*

Compco Corporation
2251 W. St. Paul, Chicago 47, Ill. *Lawrence H. Wrobel*

Connecticut Light & Power Co.
P. O. Box 2010, Hartford 1, Conn. *Robert G. Ely*

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *C. Miller*

Consolidated Gas, Elec. Light & Power Co. of Baltimore
100 W. Lexington St.,Baltimore 1, Md. *M. C. Albrittain*

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power District
1452 25th Ave., Columbus, Nebr. *W. H. Sinke*

Continental Electrical Construction Co.
3540 Southport Ave., Chicago 13, Ill. *Leo W. Witz*

Corning Glass Works
Corning, N. Y. *A. S. Tylor*

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave.,Leaside, Toronto 12, Ont. *H. L. Wright*

Cutler Light Manufacturing Co.
2026-28 N. 22d St., Philadelphia 21, Pa. *Robert T. Cutler*

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del. *W. A. F. Pyle*

Dept. of Water & Power, City of Los Angeles, Bur. of Power & Light
Box 3669, Terminal Annex, 207 So. Broadway, Los Angeles 54, Calif. *William S. Peterson*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Tayler*

Detroit Electrical Contractors Association
627-628 Hotel Book Cadillac, Detroit 26, Mich. *Carl J. Schoeninger*

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich. *W. Clifton Randall*

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

E. I. duPont de Nemours & Co., Inc. Polychemicals Dept.
Wilmington 98, Del. *R. E. Leary*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duray Fluorescent Mfg. Company
3318 W. Montrose Ave., Chicago 18, Ill. *Ludwig Dannenberg*

Duro Test Corp.
2321 Hudson Blvd., North Bergen, N. J. *James L. Cox*

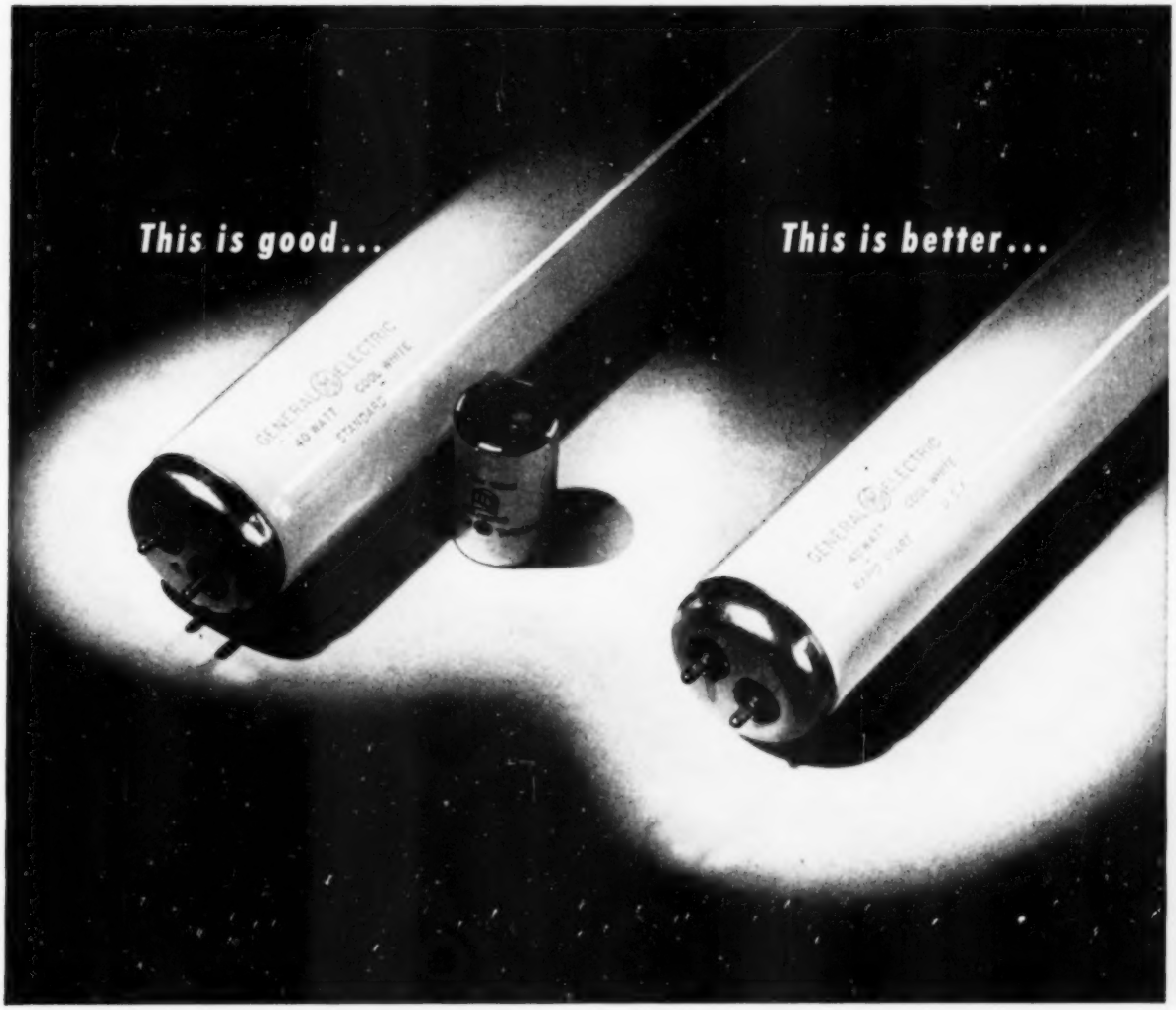
Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

East Side Metal Spinning & Stamping Corp.
1301 Elizabeth Ave., W., Linden, N. J. *M. A. Kremer*

(*Continued on page 25A*)

(*Note:* Names of Official Representatives appear in italics.)

New G-E Rapid Start lamp needs no starter, cuts maintenance



IN THE NEW RAPID START lamp circuit G-E has been able to eliminate the starter required in standard lamps to pre-heat the cathode. For that reason, maintenance is even easier, more economical than before.

This new General Electric *Rapid Start* lamp was made possible by two G-E developments: an improved triple-coil cathode that replaces the double coil in standard fluorescent lamps, and a *Rapid Start* ballast. Together, they give General Electric *Rapid Start* lamps almost instant starting and smooth, simple operation.

G-E *Rapid Start* fluorescent lamps are rapidly becoming available. Many leading fluorescent lighting fixture manufacturers are incorporating the new lamps and ballasts in their latest equipment. These two newest developments of G-E research are another reason why you can *expect* the best value from General Electric fluorescent lamps.

You can put your confidence in—

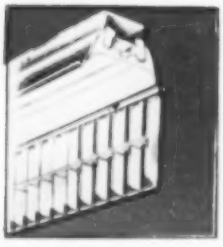
GENERAL ELECTRIC

LIGHTING EFFICIENCY

35° crosswise, 41° lengthwise shielding combined with high utilization.

Choose THE NEW 5500 SERIES GARCY recessed troffers

...because of these "ENGINEERED-IN" features



ONE PIECE LOUVER

Punched and formed in one piece with continuous outer frame for lasting rigidity. New, simplified hinging reduces maintenance.

UNIQUE COUPLING PLATE

- Lets light pass from one unit to next for more uniform brightness throughout the run.
- Wide open wireway for fast splicing.
- Simple, bolt-together coupling.

VERSATILITY

- For any type ceiling.
- 1, 2 or 3 lamp rows.
- 4, 6 or 8 ft. lengths.
- Standard fluorescent or slimline.
- Varied bottom treatments, including louvers, diffusing glass, flat or curved lenses.
- Matching Spot-a-Lites available.

GARDEN CITY PLATING and MFG. COMPANY
1760 North Ashland Avenue
CHICAGO 22, ILLINOIS

(Continued from page 22A)

Ebasco Services, Inc.
2 Rector St., New York 6, N. Y. *P. D. Brooks*

Efengee Electrical Supply Co.
949 W. Chicago Ave., Chicago 22, Ill. *Lee Mirus*

Electrical Information Publications, Inc.
20 N. Carroll St., Madison, Wis.
Lewis E. Johnston

Electric Supply Corporation
701 W. Jackson Blvd., Chicago 6, Ill.
G. M. Marks

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York 21, N. Y.
W. F. Little

Electro Silv-A-King Corporation
2000 West Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada
John Issenman

Electron Corp.
5100 South Santa Fe, Littleton, Colo.
Milt Heisner

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill. *Ray O'Leary*

Enterprise Electric Co.
6507 Euclid Ave., Cleveland, Ohio
William S. Fell

Esty Manufacturing Company
1231 W. Monroe St., Chicago 6, Ill.
Ben Trossman

Ever-Brite Products Corp.
1629 Milwaukee Ave., Chicago 47, Ill.
Jack Lipschultz

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Florida Power & Light Co.
Box 3100, Miami 30, Fla. *C. B. Fick*

Fluorescent Equipment & Mfg. Co.
5105 Cowan Ave., Cleveland 4, Ohio
Leonard S. Freeman

Fluorescent Fixtures of Calif.
3320 18th St., San Francisco 10, Calif.
Ernst O. Anders

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Framburg & Co.
3320-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The France Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio *J. H. Mayne*

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, O.io
Dave Frankel

Franklin Design Service, Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660, Oakland 4, Calif.
T. E. Rinehart

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y.
Theo. J. Brassel, Jr.

Fullerton Manufacturing Corp.
17 Chestnut St., South Norwalk, Conn.
Lawson Fullerton

Gallagher-O'Brien Electric Co., Inc.
915 W. North Ave., Chicago 22, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harvey

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave., West Lynn, Mass.
W. J. Fleming

General Electric Co., Lamp Dept.
Nela Park, Cleveland 12, Ohio *Willard C. Brown*

General Electric Supply Company
A Division of General Electric Distributing Corp.
1260 Boston Ave., Bridgeport 9, Conn.
W. W. Booth

General Fireproofing Co.
Dennick Ave., Youngstown, Ohio *J. A. Saunders*

General Lighting Products Co.
468 Frelinghuysen Ave., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill *C. E. Freeland*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Globe Lighting Products Co., Inc.
1710 Flushing Avenue, Brooklyn 6, N. Y.
Isidor Rosenblatt

Godfrey and Wing, Inc.
2110 Superior Ave., Cleveland 14, Ohio
C. G. Wing

Golde Manufacturing Co.
4888 N. Clark St., Chicago 40, Ill.
E. W. Goldberg

Grand Rapids Store Equip. Co.
1340 Monroe Ave., N. W., Grand Rapids 2, Mich.
Kenneth C. Welch

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Grayco Products
3830 N. Kedzie Ave., Chicago, Ill. *A. E. Orelove*

Great Northern Mfg. Corp.
4221 W. Harrison St., Chicago 24, Ill. *D. J. Epp*

Guardian Light Company Inc.
301 Lake St., Oak Park, Ill. *W. S. Akely*

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *Clarence Barron*

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

The Hankins Container Co.
3044 W. 106th St., Cleveland 11, Ohio
Ray T. White

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn. *Victor Ouellette*

Harvstone Manufacturing Co.
542 E. 75th St., Chicago 19, Ill. *A. M. Riskind*

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill. *R. R. Hill*

Hendrickson-Heffernan Co., Inc.
45-17 Pearson St., Long Island City 1, N. Y.
Joseph T. Manucia

Holdenline Co.
2301 Scranton Rd., Cleveland 13, Ohio
H. E. Ingraham

Hollywood Wholesale Electric Co.
6820 Romaine St., Hollywood 38, Calif.
James H. Diffenwierth

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Home Light and Power Co.
810 Ninth St., Greeley, Colo. *C. Gilbert Dressor*

House-O-Lite Corporation
2430 S. Ashland Ave., Chicago 8, Ill.
Jack R. Stone

Hub Electric Company
2219 W. Grand Ave., Chicago 12, Ill.
I. M. Fixman

Hubbard and Company
6301 Butler St., Pittsburgh 1, Pa.
C. C. Warne, Jr.

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Charles K. Lambka

Illinois Power Co.
134 East Main St., (L Box 511 B), Decatur 70, Ill. *Allen Van Wyck*

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Interstate Power Company
1000 Main St., Dubuque, Ia. *R. C. Halcombe*

Iowa Electric Light & Power Co.
Box 351 Cedar Rapids, Iowa *Sutherland Dows*

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Power and Light Co.
312 Sixth Ave., Des Moines 3, Iowa
N. Bernard Gussett

Iowa Public Service Co., East Div.
400 Commercial St., Waterloo, Iowa
C. R. Wagoner

Iowa Public Service Co., Sioux City Division
P.O. Box 778, Sioux City 4, Iowa *C. R. Tracy*

Jefferson Electric Co.
Bellwood, Ill. *L. Maurer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J. *D. I. Douglas*

Jeryl Lighting Products Inc.
42 West Cermak Rd., Chicago, Ill.
Charles Meyerson

Joleco Corporation
2513 Baldwin St., St. Louis, Mo. *George Ledbetter*

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill. *J. H. Fahey*

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 208, Wichita, Kans. *H. W. Hobson*

The Kayline Company
2480 E. 22d St., Cleveland 15, Ohio *M. A. Eskins*

Kelso-Burnett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Kerrigan Iron Works, Inc.
1033 Herman St., Nashville, Tenn. *G. E. Daniels*

Keystone Electric Manufacturing Co.
2228-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Asha*

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Richard C. Piper, Jr.

Leader Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill. *Walter Glass*

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
Dr. R. C. Machler

Libbey-Owens-Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Light Control Company
3217 Casitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

Lighting Products, Inc.
2259 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 36th St., New York 16, N. Y. *H. Stollnitz*

Line Material Co., Division of McGraw Electric Co.
800 North 8th St., Milwaukee 1, Wis. *M. C. Harth*

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

Lithonia Lighting Products Co., Inc.
Lithonia, Georgia *Robert J. Freeman*

Louisiana Power & Light Co.
142 Delaronde St., Station "A," New Orleans, La.
C. L. Osterberger

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

T. R. Lyda, Manufacturers Rep.
30 E. Georgia St., Indianapolis, Ind. *T. R. Lyda*

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
P.O. Box 950, Newburgh, N. Y. *Norman Macbeth*

Major Equipment Company Inc.
4603-19 Fullerton Ave., Chicago, Ill.
Ross O. Major

Malden Electric Co.
157 Pleasant St., Malden, Mass.
Warren K. Lawellen

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 5, N. Y.
Morris L. Markel

Markstone Manufacturing Co.
2460 W. George St., Chicago, Ill. *Martin Schwartz*

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada *Henri Martineau*

Metalcraft Products Co., Inc.
Masher & Lippincott Sts., Philadelphia 33, Pa.
Nathan Bloom

Metal Window Institute
Cheltenham, Pa. *George Hingston*

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
T. O. McQuiston

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill. *Fred Pedrigi*

Midwest Chandelier Co.
15th & Gentry Sts., No. Kansas City 16, Mo.
Sidney Lefkovitz

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
98 Angelica St., St. Louis 7, Mo. *Reed Muir*

Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson, Miss. *B. M. Davis*

Mitchell Manufacturing Company
2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

Mitchell Manufacturing Co., Ltd.
19 Waterman Ave., Toronto 13, Ont.
J. E. Landers

Modern Light Company
7809 Maplewood Industrial Court,
Maplewood 17, Mo. *J. E. Baker*

Modern Light & Equip. Co.
3812 S. Wabash Ave., Chicago, Ill.
M. L. Offenberg

Moe-Bridges Corp.
1415 Illinois Ave., Sheboygan, Wis.
Frank J. Marriet

Moe Light, Inc.
700 Oak St., Fort Atkinson, Wis. *Stanley Warner*

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

Mountain States Power Co.
236 Lyon St., Albany, Ore. *A. T. Peterson*

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall,
Pasadena 1, Calif. *E. L. Bettannier*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg., New York 1, N. Y.
Morris Thau

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I.
C. R. Broadhead

National Chemical & Manufacturing Co.
Luminall Paint Div.
3617 So. May St., Chicago 9, Ill.
John Marshall Ziv

Nelson-Tombacher Company Inc.
81 Prospect St., Brooklyn 1, N. Y.
M. J. Tombacher

New Bedford Gas & Edison Light Co.
693 Purchase St., New Bedford, Mass.
W. S. Fenstermacher

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La. *S. L. Drumm*

New York State Electric & Gas Corp.
62 Henry St., Binghamton, N. Y.
Earle C. Edwards

Niagara Mohawk Power Corp.
300 Erie Blvd. W., Syracuse 2, N. Y.
Leland D. McCormac

Northern Electric Co. Ltd.
1620 Notre Dame St., West, Montreal, Quebec
F. P. Labey

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind.
J. C. Sackman

Northern Light Company
1657 No. Water St., Milwaukee 2, Wis.
Fred Cramer

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *C. L. Dunn*

The Ohio Power Co.
301-315 Cleveland Ave., S. W., Canton 2, Ohio
C. B. Morin

The Ohio Public Service Co.
P.O. Box 6058, Cleveland 1, Ohio *C. L. Dunn*

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla. *E. W. Gray*

Omaha Public Power District
720 Electric Bldg., Omaha 2, Nebraska
E. E. Schwalm

Pacific Gas & Electric Co.
245 Market St., San Francisco 6, Calif. *O. R. Doerr*

Pacific Power & Light Co.
522 Public Service Bldg., Portland 4, Oregon
C. A. Root

Peerless Electric Limited
5585 Fullum, Montreal 36, Que. *L. A. Van Duzer*

William Penn Fluorescent Light Mfrs.
1639 S. Broad St., Philadelphia, Pa.
William Ranieri

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa. *Frank R. Knowles*

Pennsylvania Power Co.
19 E. Washington St., New Castle, Pa.
P. G. Dingledy

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa. *J. M. Stedman*

Pennsylvania Wire Glass Co.
1612 Market St., Philadelphia 3, Pa.
Dr. Frank W. Preston

The Perfeclite Company
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, jr

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa.
R. G. Rhinciffe

Philadelphia Electrical & Mfg. Co.
1228 36 N. 31st St., Philadelphia 21, Pa.
R. A. Manwaring

Phoenix Glass Co.
Monaca, Pa. *D. G. Cameron*

Pierce Electric Co.
367 W. Adams St., Chicago 6, Ill. *John H. Pierce*

Pittsburgh Corning Corp.
307 Fourth Ave., Pittsburgh, Pa.
Robert W. McKinley

Pittsburgh Plate Glass Co.
Grant Bldg., Pittsburgh 19, Pa. *R. B. Tucker*

Pittsburgh Reflector Co.
403-411 Oliver Bldg., Pittsburgh 22, Pa.
H. C. Zinsmeister

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *T. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md.
S. S. Bradford

Powerlite Devices, Limited
1870 Davenport Road, Toronto 9, Ont.
M. B. Hastings

Public Service Co. of Colo.
900 Fifteenth St., Denver, Colo. *G. B. Buck*

Public Service Co. of Indiana, Inc.
110 N. Illinois St., Indianapolis 9, Ind.
G. O. Stewart

Public Service Co. of Northern Illinois
72 W. Adams St., Chicago 3, Ill. *G. K. Hardacre*

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J. *H. P. J. Steinmetz*

Puget Sound Power & Light Co.
860 Stuart Bldg., Seattle 11, Wash.
Frank McLaughlin

Quadrangle Mfg. Co.
32 So. Peoria St., Chicago 7, Ill.
Dwight E. Worrell

Quaker City Electric Mfg. Co.
2810 East Pacific St., Philadelphia, Pa.
Reuben Haberman

Quebec Hydro-Electric Commission
107 Craig St., West, Montreal, Que.
Paul E. Poitras

Quebec Power Company
P.O. Box 1607, Quebec, Que. *Jean Saint-Jacques*

Rambusch Decorating Co.
40 W. 13th St., New York 11, N. Y.
Edward Rambusch

Revere Electric Mfg. Co.
6009-17 N. Broadway, Chicago 40, Ill.
Murray J. Whitfield

Revere Electric Supply Company
2501 W. Washington Blvd., Chicago 12, Ill.
Arthur Peterson

Rochester Gas & Electric Corp.
89 East Ave., Rochester 4, N. Y. *L. C. Twichell*

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
W. T. Reedy

Ruby Lighting Corp.
1212 S. Olive St., Los Angeles 15, Calif.
Albert Jassim

(Continued on page 29A)

JEFFERSON TRANSFORMERS GIVE YOU THE FINEST MERCURY LAMP OPERATION

FOR OUTDOOR SERVICE

The finest transformers for outdoor operation of all H-1 400 watt mercury lamps. From core and coil to seamless hot-dipped galvanized case, every modern design and construction feature has been built in for longest transformer life and maximum lamp performance.

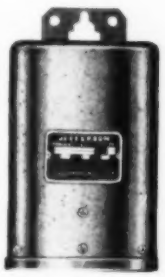
Every Jefferson Transformer is engineered to the highest quality standards. All are in deep drawn *weatherproof* cases for years of positive protection against the elements. Each has *all* the extra value features found *only* in Jefferson Transformers.

Streamlined hot-dipped galvanized case sheds water like a duck. No seams, no cracks, no place for moisture to seep in. Welded bracket has keyhole slot for easy mounting. Dura-Gray harmonizing finish for modern, attractive installations.

Large handhole gives easy access to color-coded tagged leads. Correct installation is quick, positive.

Patented Jefferson Adaptor converts wall and post mounting transformers to pole top units in minutes. Transformer stocks can be cut drastically as one type transformer can be mounted wherever needed—wall, post, or pole-top with an adaptor.

Universal Adaptor fits any pole top from 2-1/2" to 4" O.D. — fills every need. It's inexpensive, easy to mount. Provides a solid, weatherproof base for the transformer. Comes fully equipped with outlet fittings.



FOR INDOOR SERVICE

Jefferson two-lamp transformers cut installation costs by reducing wiring up to 50%. High power factor design delivers maximum lumens per watt. Failure of one lamp does not affect the operation or brilliancy of the remaining lamp. Stroboscopic effect is minimized since the two lamps operate out of phase with each other.

Mercury and incandescent lamp wiring facilities are provided at both ends in ample wiring compartments. Leads are color-coded and tagged. One-half and ¾" knockouts are provided in both sides of each wiring compartment and in both end plates for trouble free wiring. Condenser is mounted in a separate compartment for efficient cooling and maximum life.

●

Jefferson Single Lamp Transformers give you every vital feature for top-notch lamp operation and economy. Press-fit riveted core, double varnished core and coil assembly, three primary taps (not just two), easy mounting brackets, and incandescent as well as mercury lamp leads out of both ends are a few of the outstanding Jefferson features. You get all these extra values in Jefferson Transformers, yet they cost no more than ordinary transformers.

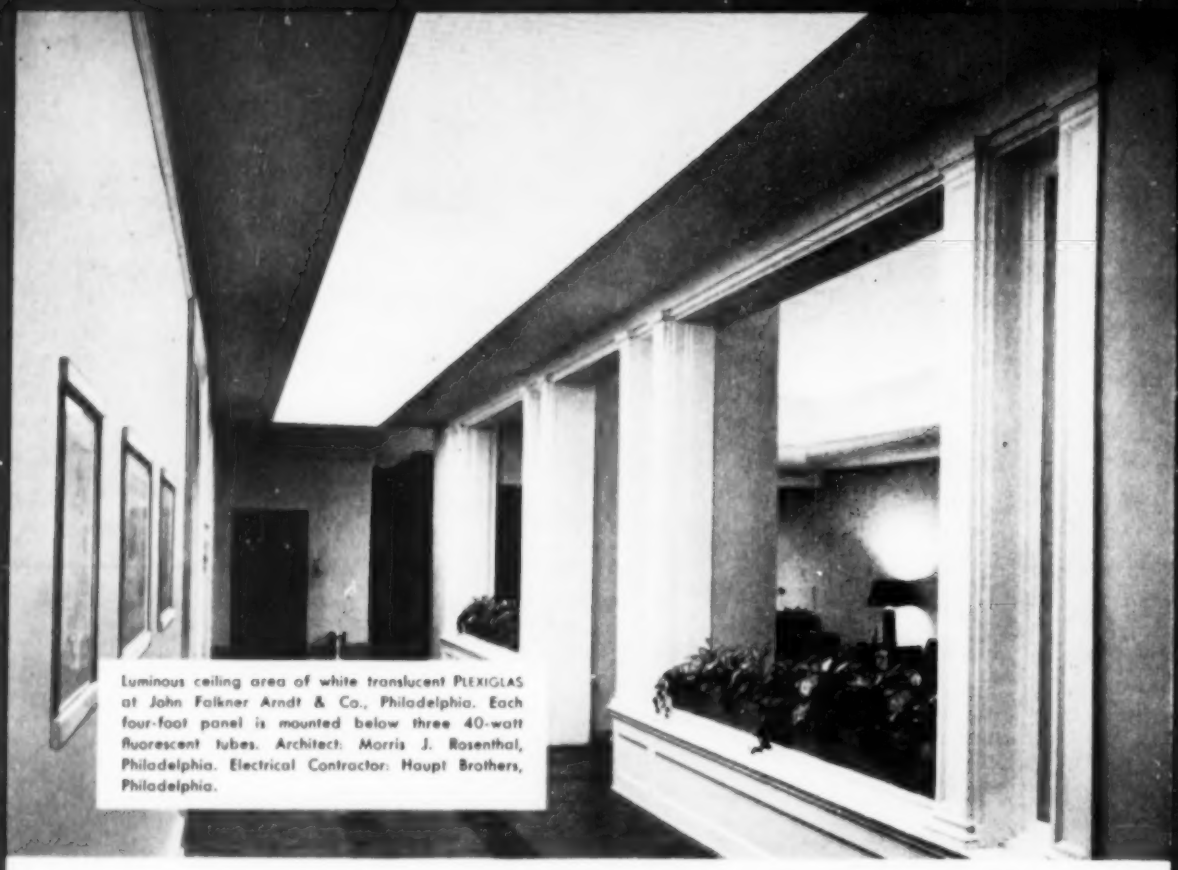
***Specify* Jefferson for the best operation of every mecury lamp installation. New 16-page illustrated Bulletin 521-5 gives complete data on H-1 400 watt models as well as the new Jefferson Transformers for H-12 and H-15 1000 watt mercury lamps.**

TWO-LAMP TRANSFORMER

SINGLE LAMP TRANSFORMER

JEFFERSON ELECTRIC COMPANY
BELLWOOD, ILLINOIS

Jefferson Transformers



Luminous ceiling area of white translucent PLEXIGLAS at John Falkner Arndt & Co., Philadelphia. Each four-foot panel is mounted below three 40-watt fluorescent tubes. Architect: Morris J. Rosenthal, Philadelphia. Electrical Contractor: Haupt Brothers, Philadelphia.

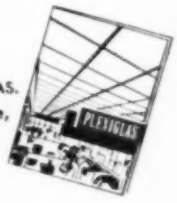
For Fixture-Free Appearance...PLEXIGLAS

Corrugated panels of white translucent PLEXIGLAS, mounted as part of the ceiling beneath fluorescent tubes, are important to the inviting appearance of this entrance area in a Philadelphia office.

Notice how the built-in luminous area is in keeping with the clean design of the lobby. Evenly diffused illumination with low source brightness is spread over the entire length of the corridor, without a succession of hanging fixtures that would mar the symmetry of the room design. Because the PLEXIGLAS acrylic plastic panels diffuse completely the light from the concealed lamps, the effect is one of daylighting, as if the ground-floor area were skylighted.

As a diffusing medium, PLEXIGLAS offers other advantages. Rigid, strong, light in weight, it can be handled easily and safely during installation, cleaning and relamping. And because it resists breakage and discoloration, it gives long, trouble-free service.

If you're interested in better lighting, investigate the possibilities of luminous ceilings and lighting fixtures of PLEXIGLAS. We'll be glad to send you our brochure, PLEXIGLAS FOR LUMINOUS CEILINGS.



PLEXIGLAS is a trademark, Reg. U. S. Pat. Off. and other principal countries of the Western Hemisphere.

CANADIAN DISTRIBUTOR: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*

PLEXIGLAS is listed in Sweet's Architectural File, Section 14f/Ro.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

(Continued from page 26A)

Ruby-Philite Corp.
32-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa. *T. W. Lauer*

Ryall Electric Supply Co.
1160 Stout, Denver, Colo. *C. O. Ryall*

The Safety Car Heating & Lighting Co.
P.O. Box 904, New Haven 4, Conn. *J. J. Kennedy*

St. Joseph Ry., Light, Heat & Power Co.
520 Francis St., St. Joseph 2, Mo. *F. P. O'Connor*

Sandee Manufacturing Co.
5050 Foster Ave., Chicago, Ill. *R. L. Schramm*

Sandel Manufacturing Co.
3618 So. Loomis Place, Chicago 9, Ill. *A. L. Sandel*

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif. *H. G. Dillin*

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

Schomer Electric Supply
164 S. Broadway, Aurora, Ill. *C. Petrik*

The Albert Sechrist Mfg. Co.
1717 Logan St., Denver 5, Colo. *K. L. Francis*

L. J. Segil Co.
2500 W. North Ave., Chicago, Ill.
Louis Rosenstein

Shalda Manufacturing Co., Inc.
855 S. Fernando Blvd., Burbank, Calif.
William Shalda

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que.
Chas. H. Talbot

The Sherwin-Williams Co.
101 Prospect Ave., N. W., Cleveland 1, Ohio
J. A. Meacham

Silvray Lighting, Inc.
R.K.O. Bldg., Radio City, New York 20, N. Y.
J. M. Gilbert

Smithcraft Lighting Division
A. L. Smith Iron Company
217 Everett Avenue, Chelsea 50, Mass.
Hugh M. Nazor

Smoot-Holman Co.
521 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

Sola Electric Co.
4633 W. 16th St., Chicago 50, Ill. *L. C. Marschall*

Solar Light Mfg. Co.
1357 S. Jefferson St., Chicago 7, Ill. *A. Lazerson*

The Solex Co. Ltd.
280 Faillon St.,West, Montreal, Que.
Leon Beauchamp

Southern Calif. Edison Co., Ltd.
601 West 5th St., Los Angeles 53, Calif.
Roy E. Dahlin

Southern Canada Power Co., Ltd.
355 St. James St., West, Montreal, Que.
George R. Atchinson

Southern Colorado Power Co.
Box 75, Pueblo, Colo. *E. H. Pemberton*

Southern Indiana Gas & Elec. Co.
P.O. Box 569, Evansville 3, Ind. *C. K. Graham*

Southern Lighting Mfg. Co.
501 Elwell St., Orlando, Fla. *Max K. Aulick*

Southwestern Gas & Elec. Co.
Box 1106, Shreveport, La. *J. E. Elliott*

Southwestern Public Service Co.
Dallas 1, Texas *J. E. Cunningham*

Stanley Electric Mfg. Co.
3700 S. 80th St., Philadelphia, Pa.
Bernard S. Heller

Steber Manufacturing Co.
2700 Roosevelt Rd., Broadview, Maywood, Ill.
Robert J. Betal

Steiner Electric Co.
3500 Milwaukee Ave., Chicago 41, Ill.
George S. Steiner

Sterling Reflector & Mfg. Co.
3249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Stonco Electric Products Co.
489 Henry St., Elizabeth 4, N. J. *H. W. Spence*

Sunbeam Lighting Co.
777 E. 14th Place, Los Angeles 11, Calif.
Herbert L. Krieger

Sun-Lite Manufacturing Co.
2555 Bellevue Ave., Detroit 7, Mich. *Fred Binder*

Sun-Ray Fluorescent Co.
2025 South Michigan Ave., Chicago, Ill.
Jerome Gimbel

Sylvania Electric Products, Inc.
1740 Broadway, New York 19, N. Y. *D. P. Caverly*

Tampa Electric Co.
Cass & Tampa Sts., Tampa 1, Fla. *F. J. Gannon*

Frank C. Teal Co.
3222-24 E. Jefferson, Detroit 7, Mich.
Harold C. Smith

Texas Electric Service Co.
Electric Bldg., Fort Worth 1, Texas
R. E. Hendricks

Thompson Electric Co.
1101 Power Ave., N. E., Cleveland 14, Ohio
Thayer B. Farrington

Toledo Edison Co.
Edison Bldg., Toledo 4, Ohio *Charles A. Harrison*

Toronto Hydro-Electric System
14 Carlton St., Toronto 2, Ont. *Wilson J. Wylie*

Triangle Electric Mfg. Company, Inc.
1112 Southwest First St., Miami, Fla. *Lee Minor*

Triangle Industries
600 W. Adams St., Chicago, Ill. *Leonard Cohen*

Tri-Part Mfg. Company
934 Plum St., Detroit 1, Mich. *Julius Reznik*

Tristate Electrical Supply Co., Inc.
38 S. Potomac St., Hagerstown, Md.
Robert A. Stott

Tru-Lite Ltd.
824 Notre Dame St., W., Montreal, Que.
Omer M. Trudel

Underwriters' Laboratories, Inc.
207 E. Ohio St., Chicago 11, Ill. *Ferd. Neumer*

Union Electric Co. of Missouri
12th & Locust Sts., St. Louis 1, Mo. *W. L. Berry*

Union Metal Mfg. Co.
Canton 5, Ohio *W. A. Porterfield*

Unistrut Corp.
4118 Monroe Ave., Wayne, Mich.
James W. Attwood

Unistrut Products Company
1013 West Washington Blvd., Chicago 7, Ill.
George W. Butler

The United Illuminating Co.
80 Temple St., New Haven 6, Conn. *E. B. Haskell*

United Manufacturing Company
Div. United Advertising Corp.
41 Haig St., Hamden 14, Conn. *Richard O. Gibbs*

Utah Power & Light Co.
Box 899, Salt Lake City 10, Utah *W. A. Huckins*

John C. Virden Co.
6009-6103 Longfellow Ave., Cleveland 3, Ohio
W. G. Sawyer

John C. Virden, Ltd.
19 Curity Ave., Toronto, Ont. *P. G. Kirkpatrick*

Virginia Electric & Power Co.
Richmond, Va. *J. G. Holtzclaw*

Voight Company
1636-38 N. Carlisle St., Philadelphia 21, Pa.
C. J. Frank

The F. W. Wakefield Brass Co.
Vermilion, Ohio *F. F. Wakefield*

Warren Electric Co.
P.O. Box 2594, Houston, Texas *J. R. Thompson*

Wasco Flashing Company
87 Fawcett St., Cambridge, Mass.
Selig M. Friedberg

The Washington Water Power Co.
P.O. Drawer 1445, Spokane 6, Wash.
Carl L. Hoffman

The Watson Standard Co.
225 Galveston Ave., Pittsburgh 12, Pa.
H. E. Striker

Welsbach Engineering and Management Corp.
1500 Walnut St., Philadelphia 2, Pa. *H. H. Adams*

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 1, Ohio
(P.O. Box 5817) *Burt S. Burke*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill. *B. H. Boatner*

Westinghouse Lamp Div.
Bloomfield, N. J. *Samuel G. Hibben*

West Penn Power Co.
14 Wood St., Pittsburgh 30, Pa. *Harry Restofski*

Wheeler Reflector Co.
275 Congress St., Boston 10, Mass. *K. A. Sawin*

Wiedenback-Brown Co., Inc.
111 Eighth Ave., New York 11, N. Y.
W. C. Stockberger

R. & W. Wiley, Inc.
119 Dearborn St., Buffalo 7, N. Y.
Robert C. Graves

H. E. Williams Products Co.
108 S. Main St., Carthage, Mo. *F. B. Williams, Jr.*

Wilmot Castle Co.
1255 University Ave., Rochester 7, N. Y.
E. H. Greppin

J. A. Wilson Lighting & Display Ltd.
9 Morrison St., Toronto, Ont. *J. A. Wilson*

The Windsor Utilities Comm., Hydro Div.
149 Chatham St., W., Windsor, Ont. *W. A. Shaw*

The Wiremold Company
Hartford 10, Conn. *D. Hayes Murphy*

Wisconsin Electric Power Co.
Public Service Bldg., Milwaukee 1, Wis.
G. W. Van Derzee

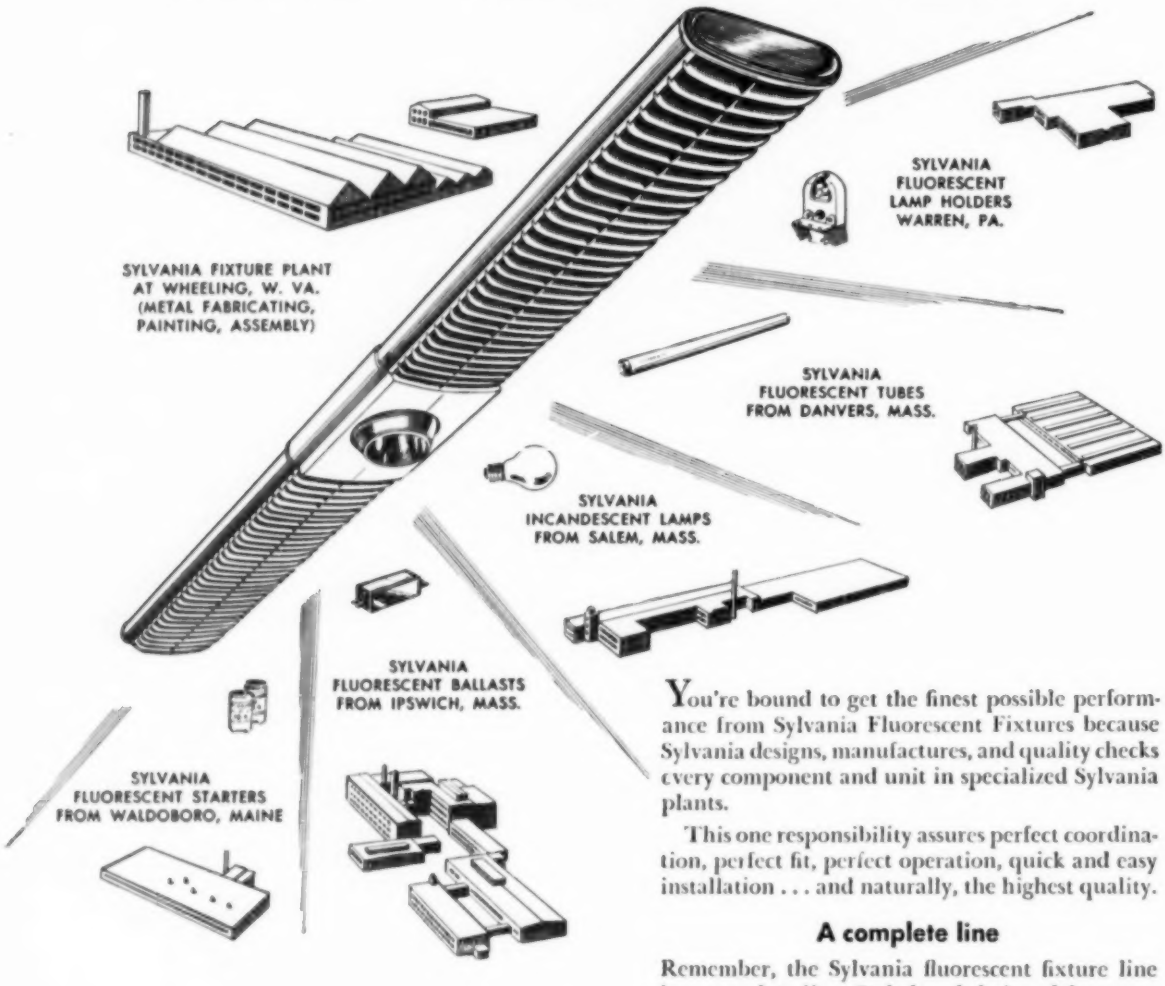
Wisconsin Power & Light Co.
122 W. Washington Ave., Madison 1, Wis.
J. D. Howard

Wisconsin Public Service Corp.
Green Bay, Wis. *A. G. Bur*

Worcester County Electric Co.
11 Foster St., Worcester, Mass. *Fred E. Littlefield*

ONE MANUFACTURER... ONE RESPONSIBILITY

Guarantee "Fluorescent at its Finest"


SYLVANIA FIXTURE PLANT AT WHEELING, W. VA. (METAL FABRICATING, PAINTING, ASSEMBLY)
SYLVANIA FLUORESCENT LAMP HOLDERS WARREN, PA.
SYLVANIA FLUORESCENT TUBES FROM DANVERS, MASS.
SYLVANIA INCANDESCENT LAMPS FROM SALEM, MASS.
SYLVANIA FLUORESCENT BALLASTS FROM IPSWICH, MASS.
SYLVANIA FLUORESCENT STARTERS FROM WALDOBORO, MAINE

You're bound to get the finest possible performance from Sylvania Fluorescent Fixtures because Sylvania designs, manufactures, and quality checks every component and unit in specialized Sylvania plants.

This one responsibility assures perfect coordination, perfect fit, perfect operation, quick and easy installation . . . and naturally, the highest quality.

A complete line

Remember, the Sylvania fluorescent fixture line is a complete line. Styled and designed for every need . . . for offices, factories, stores, schools, and homes.

Backed by the Broadest Guarantee in the Lighting Industry

Sylvania Fluorescent Fixtures are covered by a complete written guarantee which includes every unit and part. Tubes, starters, ballasts and all other components are guaranteed for one entire year from date of installation.

SYLVANIA

Sylvania Electric Products Inc., 1740 B'way, N. Y. 19, N. Y.

FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS

Engineered by Specialists to meet your needs and specifications

Kopp lenses

EVERY Kopp Glass Lens is *designed* to meet some special set of conditions, *made* to meet exact specifications, and *checked* to assure complete compliance with all requirements.

The specialized knowledge needed for these operations has been developed through many years of specialization in the engineering and manufacturing of lenses. Kopp Laboratories are staffed and equipped to study your requirements and to develop lenses, color filters and roundels that accomplish your objectives. Manufacturing functions are performed by men skilled through long experience in the various operations.

This complete organization is at your service whenever you have a problem involving lighting glassware.

KOPP GLASS

KOPP GLASS, Inc.
SWISSVALE, PA.

How I.E.S. Helps The FIXTURE MANUFACTURER

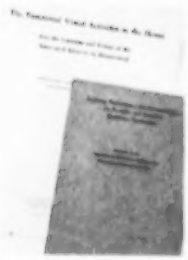
Some of the services of the Illuminating Engineering Society that can be of daily aid to every fixture manufacturer. There are many other dividends the fixture manufacturer receives from his small investment.

Research Projects

Scientific research financed by I.E.S. develops basic illumination data that is placed at the disposal of every manufacturer, to contribute to continued improvement of lighting fixtures.

Standard Practices

To help manufacturers better to adapt their equipment to the needs of varied markets, I.E.S. Standard Practices analyze the demands of specific fields, show which equipment features are most satisfactory.

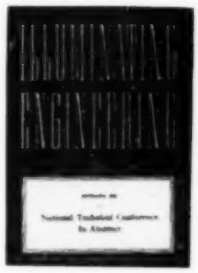


Lighting Performance Recommendations

I.E.S. Performance Recommendations, covering all types of luminaires, provide manufacturers with a basis for specification of luminaire performance—play an important part in industry certification programs.

"Illuminating Engineering"

Published monthly by I.E.S., "Illuminating Engineering" is the leading journal of its kind—provides complete and authoritative information on all phases of illumination design, manufacture and use.

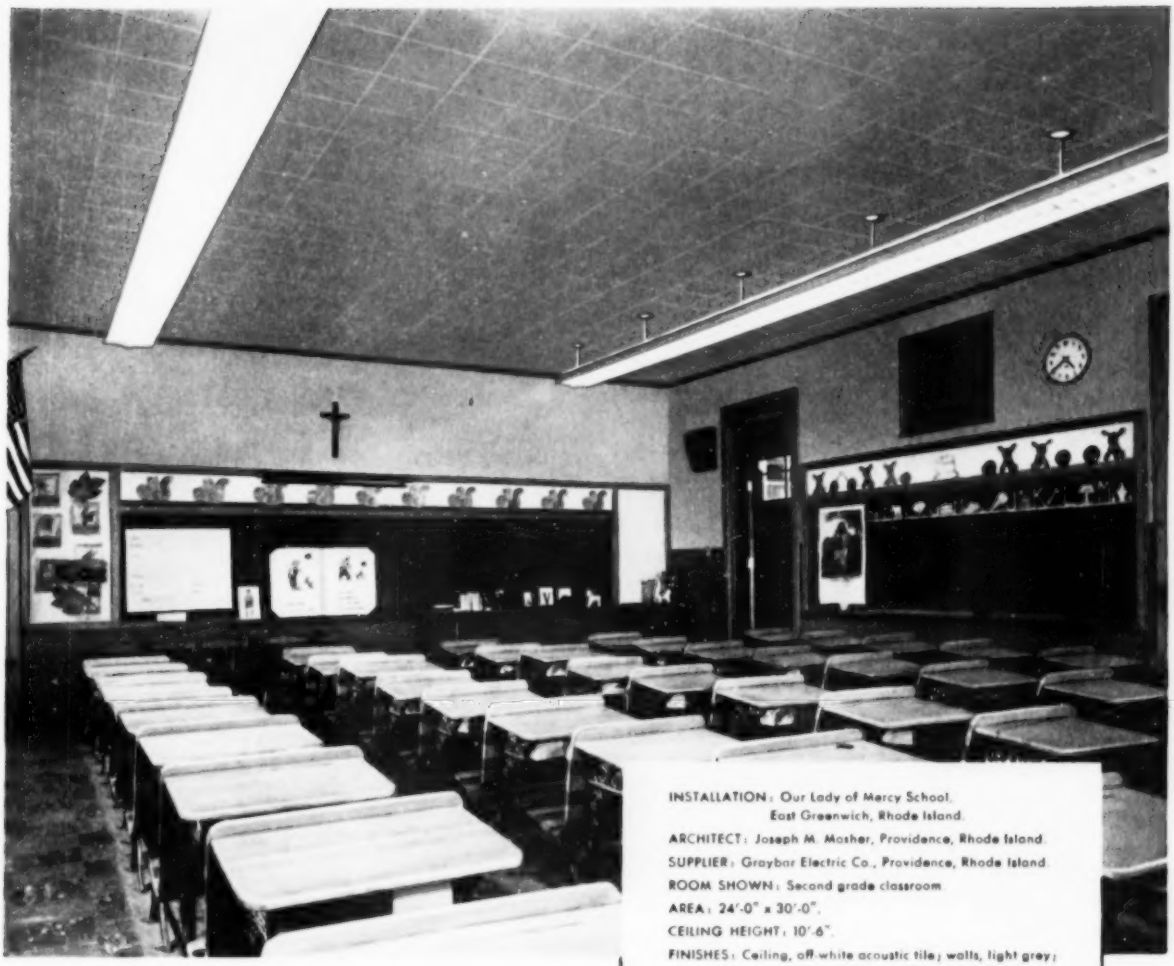


Meetings—Local and National

Provide an opportunity for the interchange of ideas and information between representatives of fixture manufacturers and others in the lighting industry.

Illuminating Engineering Society

1860 Broadway *New York 23, New York*



INSTALLATION: Our Lady of Mercy School.
East Greenwich, Rhode Island.
ARCHITECT: Joseph M. Mosher, Providence, Rhode Island.
SUPPLIER: Graybar Electric Co., Providence, Rhode Island.
ROOM SHOWN: Second grade classroom.
AREA: 24'-0" x 30'-0".
CEILING HEIGHT: 10'-6".
FINISHES: Ceiling, off-white acoustic tile; walls, light grey; floor, brown tile; chalkboards, black; woodwork and desktops, light natural wood.
FIXTURES: Litecontrol No. 4624 mounted on 8" stems. Cutoff 38° crosswise, 26° lengthwise. Standard cool white 40-watt lamps.
WATTS PER SQUARE FOOT: 1.7.
INTENSITY: At desktop level, 30 footcandles in service.

LOW BUDGET SCHOOL WITH

HIGH LEVEL LIGHTING

. . . by LITECONTROL

Built with little more than a shoestring through the efforts of Father Brady, the curate, this Parochial School contains many interesting cost-cutting features. One of the best is LITECONTROL'S attractive lighting fixture No. 4624.

Extremely efficient (86%), it combines low initial cost with unusually easy maintenance.

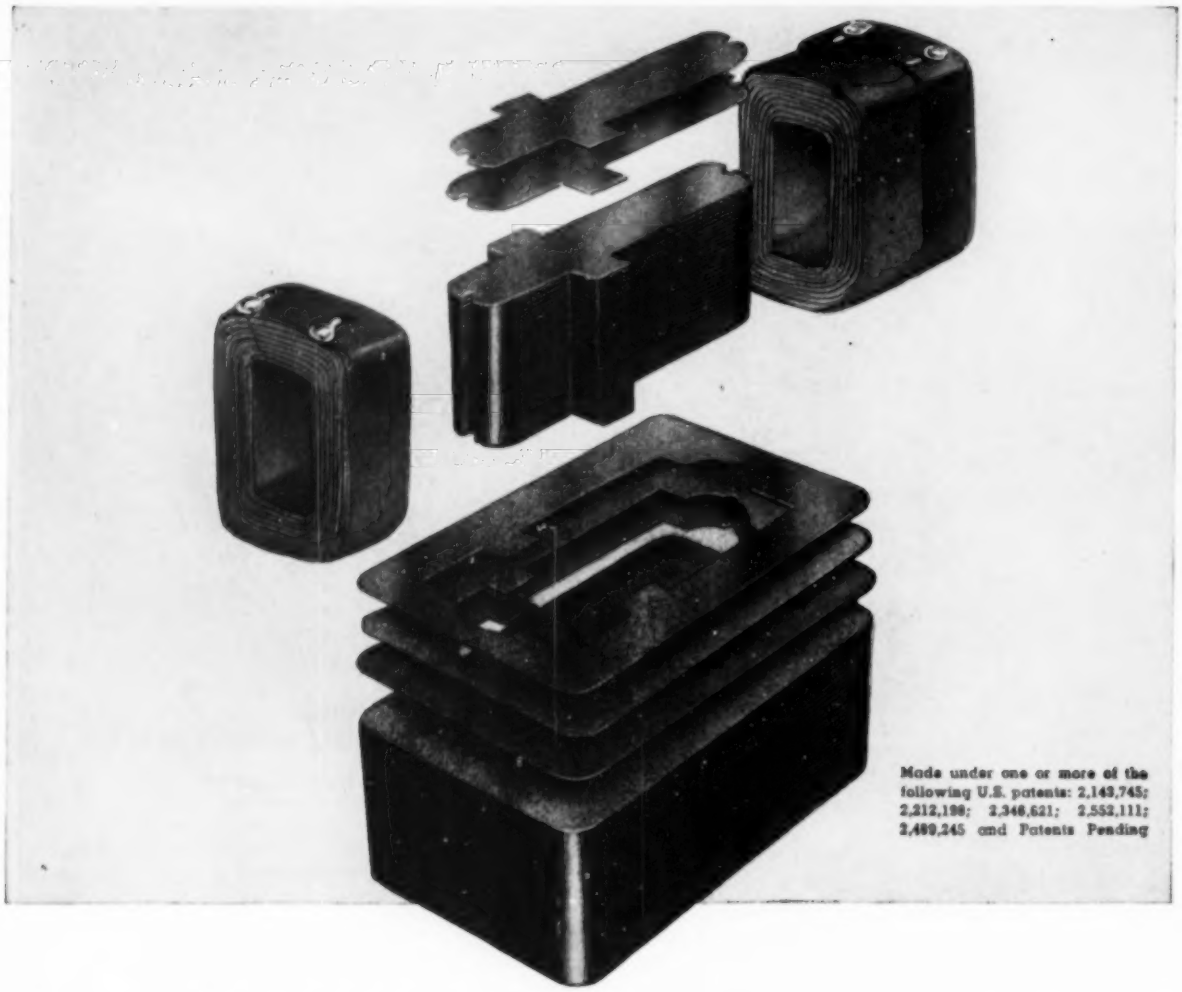
Curved metal side panels are illuminated by reflected light from ceiling and walls, thus showing a luminous appearance and practically eliminating contrast between fixtures and ceiling. Smooth curved sides and lamps are cleaned from above with just one pass of a tank type vacuum cleaner. Baffles are hinged from either side and may be installed or removed without use of tools.

Another example of the "More Light and Looks for Your Money" you get with *every* LITECONTROL Fixture. It will pay you to know the *complete* line. See your local LITECONTROL man.

LITECONTROL
Fixtures

LITECONTROL CORPORATION
36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS



Made under one or more of the following U.S. patents: 2,143,745; 2,212,198; 2,346,621; 2,552,111; 2,489,245 and Patents Pending

Why a "PRESSED-IN" Core in fluorescent ballasts?

. . . because "pressed-in core" construction insures uniform physical structure and consistent operating characteristics. The "pressed-in core" also contributes markedly to quiet operation. The precision die cut laminations and jig assembly of core and coil produces a solid unit, minimizing magnetic hum.

In 1941 Sola Electric Co. engineers designed the first fluorescent ballast with a "pressed-in core" construction. Shortly after, Sola Ballast Catalog Number W2-40 was first offered to the young fluorescent lighting industry. This significant Sola "first" immediately set a new industry standard.

Today you still get the latest engineering advances from Sola. Before you specify ballasts, compare design, fabrication and performance. You will soon see why consulting engineers, fixture manufacturers, and large fluorescent lighting users specify Sola Ballasts . . . the ballast they know is always the leader in technological improvements . . . cooler operating, quieter, dependable *Sola Fluorescent Ballasts*.

SOLA *Fluorescent* **BALLASTS**

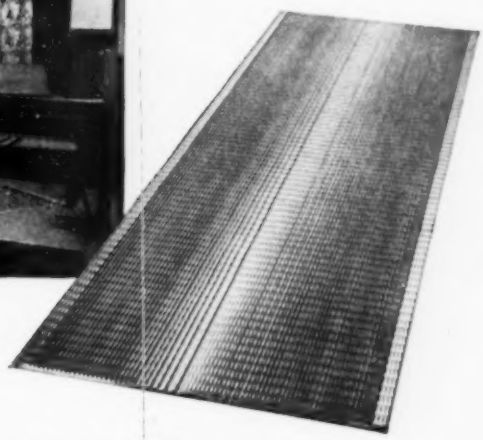
Are you on our technical mailing list? If you would like to regularly receive Sola literature on lighting transformers please write to us. Ask that your name be placed on Technical Lighting Mailing List C.

• Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs • Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois

Installation: Emporium Store, Stonestown Development Project, San Francisco

Architect: Welton Becket and Associates, Los Angeles

Fixture Manufacturer: Haluk Lighting and Manufacturing Co., San Francisco



Control of fluorescent lights by Corning Lens Panels puts the right light where it is needed, eliminating fixture brightness, glare and shadows. Merchandise is shown in *true color*. Pyrex Lenslites offset incandescent light beams, highlighting rugs hanging on the walls and adds dramatic interest to the over-all display.

A combination of incandescent and fluorescent light is achieved in these unique circular fixtures. The incandescent source in the center is surrounded by fluorescent lamps and the two sources are blended into a uniform light through Alba-Lite.

Here's ladies' wear, silverware and gifts look their best because Corning Lens Panels direct true-color light to individual counters while Pyrex Lenslites provide highlights for contrast. Notice how the fixtures blend with the over-all modern appearance of the area.

Direct beaming of incandescent light is exceptionally important in the beauty shop. Pyrex Lenslites do this in a particularly effective manner, while adding to the decor of the shop itself.

How this store got exactly the *right lighting* for each department

Each department in the new Emporium in San Francisco is lighted to do a special job . . . show off various types of merchandise to best advantage.

For example, where control of fluorescent lighting is required, Corning Lens Panels provide the precise answer. Water-white crystal glass lenses transmit true color, eliminate shadows and glare, minimize fixture brightness.

In some locations, such as the rug department, Corning Lens Panels are combined with Pyrex Lenslites which direct incandescent light in offset or spot light beams to highlight individual items.

Where highlights alone are desired, Pyrex Lenslites are used by themselves. Or they are combined with Corning Alba-Lite for use in such locations as the Boys' Department where display lighting plus soft over-all diffusion of fluorescent lighting is indicated.

Wherever used, Corning engineered lightingware not only adds to the sales appeal of the merchandise, but beautifies the store itself . . . gives it a sparkling, up-to-date appearance. Booklet LS-32 is packed with helpful data and describes Corning's complete line of engineered lightingware. A copy is yours for the asking. Use the coupon.

Corning Glass Works

PYREX

CORNING, NEW YORK

Corning means research in Glass

CORNING GLASS WORKS, Dept. IE-2, Corning, N. Y.
Please send me Bulletin LS-32 describing Corning's full line of Engineered Lightingware.

Name_____ Title_____

Firm_____

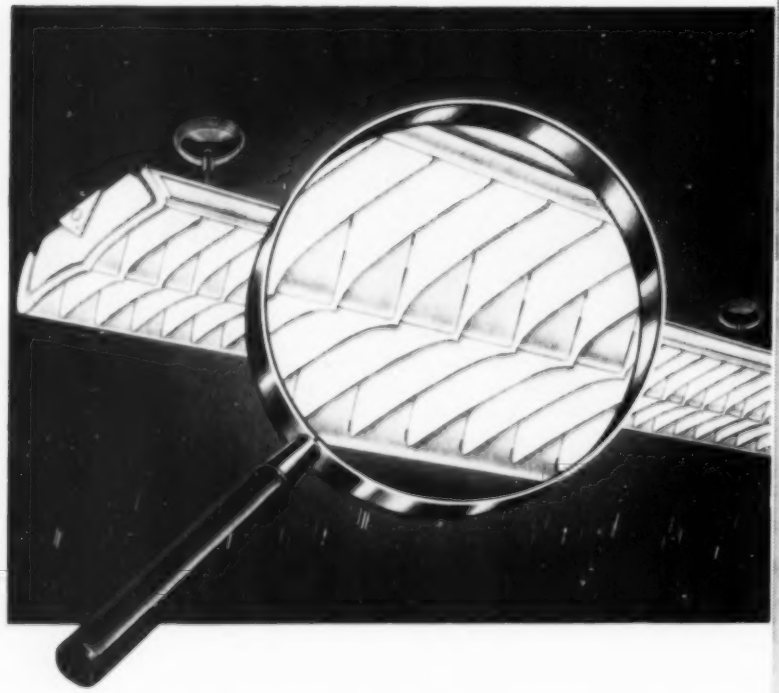
Address_____

City_____ Zone____ State_____

Day-Brite "Close-Up" Quality

GIVES YOU EXTRA VALUE

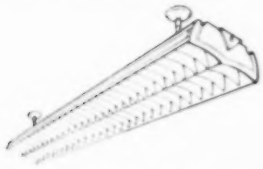
to put into your lighting specifications



THIS IS A CLOSE-UP of the *interlocking louver* feature of Day-Brite's LUVEX fixtures. Each crosswise louver is firmly locked in the center "V" louver and both side rails. The whole shielding unit is rigid. It won't sag. It won't rattle. Louvers will not twist or bend out of shape while the fixture is being cleaned.

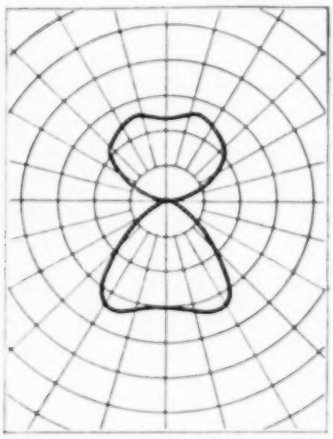
IT IS IMPORTANT for you to know about this "close-up" quality feature. It is one of many reasons you specify *extra value* when you specify LUVEX.

DAY-BRITE'S LUVEX®
...84% EFFICIENT



There must be reason for LUVEX's enthusiastic acceptance among lighting men from coast to coast. There must be reason for the great sales records this Slimline series has made during the past two years.

ONE REASON IS EXTREMELY HIGH EFFICIENCY—the result of years of planning and engineering before LUVEX reached the market.



THE TWO LIGHT LUVEX with standard 35/25 cut-off (curve shown above) has an overall efficiency rating of 84.1%. The four light LUVEX with standard cut-off rates even higher at 86.8%—a truly remarkable performance.

A new LUVEX bulletin has just been prepared. For the complete LUVEX story write today for bulletin OD-572.

* * *

Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Missouri. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

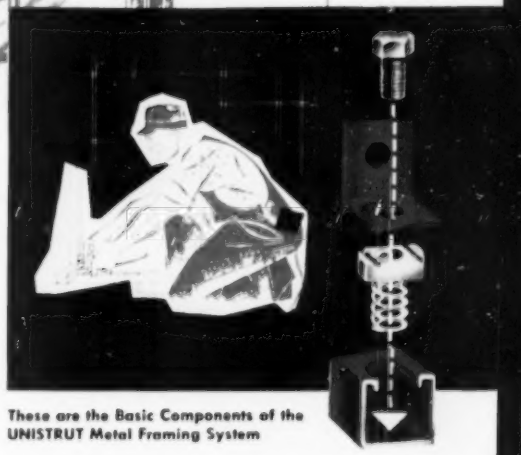
"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

317

AIA File No. 14-G
UNISTRUT
100% ADJUSTABLE • 100% REUSABLE
NO WELDING • NO DRILLING
NO SPECIAL TOOLS OR SKILLED HELP NEEDED
CATALOG NO. 800

New

FREE 84 PAGE UNISTRUT® Pocket Catalog NO. 800



These are the Basic Components of the UNISTRUT Metal Framing System

for the MAN ON THE JOB!

84 pages crammed with ideas, pictures and data on how to frame, hang, support and mount all kinds of mechanical and electrical equipment with adjustable UNISTRUT All-purpose Metal Framing.

Perfect for the man on the job—most useful, too, as a handy reference catalog for the architect, engineer, draftsman, contractor, or builder. Just pocket size, easy to handle, always within reach when you want it. Order your free copy of the *NEW* UNISTRUT Catalog No. 800 today! With UNISTRUT channel and fittings you can build all types of conduit, cable, pipe and tubing hangers and supports, framing, mounts, racks, tables, benches, and many other structures with just a hacksaw and a wrench. No drilling, no welding, 100% adjustable and re-usable.

The UNISTRUT system of mechanical supports provides great strength without bulk. It's easy to work with, lasts indefinitely, and the finished structure assures neat and orderly appearance.

Write for your copy today! **FREE**

UNISTRUT Products are Bonderized

U. S. Patent Numbers: 2327587 2329815 2345650 2363382 2380379 2405631 2541908 Other Patents Pending

The World's Most UNISTRUT **Flexible All-Purpose Metal Framing**

Distributors and Warehouse Stocks in Principal Cities—Consult your Telephone Directories

UNISTRUT PRODUCTS COMPANY
1013 W. Washington Blvd.
Chicago 7, Illinois Dept. L2

Please send me a copy of the new UNISTRUT Pocket Catalog No. 800, without obligation.

Name _____

Company _____

Address _____

City _____ Zone ____ State _____

CHAMPION DIAMONDS

for Industry

Look for the CHAMPION Diamond Mark on every Fluorescent and Incandescent Lamp whatever the lighting fixture — and you can be certain of the finest and most economical light your money can buy . . . **Here's why!**

CHAMPION LAMPS
are produced, inspected and tested to meet the exacting standards of performance and long service that are expected of *industrial* equipment.

CHAMPION LAMPS
are backed by fifty-three years of experience in the manufacture of lamps for industry—all kinds—vibration service, rough service, spot, flood, etc.

CHAMPION LAMPS
offer you the services of trained lighting engineers on any special lighting or lamp problems.

CHAMPION LAMPS
are recommended and stocked by nearby electrical or industrial supply houses that can give prompt, intelligent attention to your lamp needs.

Buy the Lamp of **CHAMPION** *Value*

CHAMPION SINCE 1900

CHAMPION LAMP WORKS
Lynn, Massachusetts
A DIVISION OF CONSOLIDATED ELECTRIC LAMP CO

(Continued from page 20A)

CORNHUSKER CHAPTER

Associate Member:
Joens, K. M., Omaha Public Power District, Omaha, Neb.

EASTERN NEW YORK CHAPTER

Associate Member:
Miller, N. A., M. Gold & Son, Schenectady, N. Y.

FLORIDA CHAPTER

Associate Member:
Heim, J. A., Heim & Heim Architects, Avon Park, Fla.

FOREIGN NON-SECTION

Members:
Garcia, V. M., 1357 Ponce de Leon Ave., Santurce, P. R.
Volckaert, A., Anc. Ets. Andre Closset S. A., 48 Quai du Commerce, Brussels, Belgium.

Associate Members:
Johnston, N. R., Australian General Electric Co. Ltd., 32 Adelaide St., Brisbane, Queensland, Australia.
Matsuda, Chozaburo, Electrical Engineering Institute, Kyoto University, Kyoto, Japan.

GEORGIA SECTION

Members:
Brunner, Harry, Harry Brunner & Associates, Atlanta, Ga.
Edwards, W. L., 1429 Peachtree St., Atlanta, Ga.

Associate Members:
Hamilton, T. A., Westinghouse Electric Corp., Chamblee, Ga.
Harris, M. D., Maxwell Air Force Base, Maxwell, A.F.B., Ala.
Paschall, P. A., Westinghouse Electric Corp., Birmingham, Ala.

INDIANA CHAPTER

Member:
Blythe, J. D., Indianapolis Power & Light Co., Indianapolis, Ind.

INLAND EMPIRE CHAPTER

Associate Member:
Bryant, B. G., Sylvania Electric Products Inc., Spokane, Wash.

MARYLAND SECTION

Associate Member:
Schrader, L. G., Westinghouse Electric Supply Co., Baltimore, Md.

MICHIGAN SECTION

Associate Member:
Tarrant, W. E., Standard Electric Co., Saginaw, Mich.

MID-SOUTH CHAPTER

Member:
McGown, D. T., Daniel T. McGown & Associates, Memphis, Tenn.

Associate Members:
Buxton, J. A., Southern College of Optometry, Memphis, Tenn.
McCrory, C. O., Jr., McCrory Electric Co., Memphis, Tenn.
Schleifer, C. E., 979 E. McLemore, Memphis 6, Tenn.

Student Members:
Herndon, B. R., Southern College of Optometry, Memphis, Tenn.
Jolson, B. W., Southern College of Optometry, Memphis, Tenn.
Neuman, Bertram, Southern College of Optometry, Memphis, Tenn.

MILWAUKEE SECTION

Associate Members:
England, R. N., Herman Andrae Electrical Co., Milwaukee, Wis.
Fosdal, F. A., Fosdal Electric, Waukesha, Wis.
Pearson, G. L., Morley Murphy Co., Green Bay, Wis.
Russell, D. H., Herman Andrae Electrical Co., Milwaukee, Wis.

MISSISSIPPI CHAPTER

Associate Members:
Richardson, E. K., Mississippi Power Co., Meridian, Miss.
Weifenbach, R. H., Cabell Electric Co., Jackson, Miss.

MONTREAL SECTION

Member:

Hines, S., Canadair Ltd., Montreal, Que.

MOTHER LODE CHAPTER

Associate Members:

Buescher, E. W., Westinghouse Electric Corp., Sacramento, Calif.

Naylor, A. J., Jr., Geo. C. Foss Co., Sacramento, Calif.

NEW ENGLAND SECTION

Associate Members:

Brann, W. H., Central Maine Power Co., Portland, Maine.

Morrison, I. W., Westinghouse Electric Corp., Belmont, Mass.

Somes, D. W., Graybar Electric Co. Inc., Providence, R. I.

NEW MEXICO CHAPTER

Associate Members:

George, I. J., Amerco Electric Contracting Co., Albuquerque, N. M.

Li, I. W., Reynolds Electrical & Engineering Co. Inc., Albuquerque, N. M.

McGillan, E. T., III, McGillan Sales Co., Albuquerque, N. M.

Pearce, J. P., Highland Engineering & Sales Co., Albuquerque, N. M.

Perks, T. C., State Electric Supply Co. Inc., Albuquerque, N. M.

Whitaker, J. E., State Electric Co. Inc., Albuquerque, N. M.

Yearout, J. N., Yearout Electric Co. Inc., Albuquerque, N. M.

NEW ORLEANS SECTION

Associate Members:

Hall, T. L., Interstate Electric Co., New Orleans, La.

Laubersheimer, R. J., Jr., G. W. Milner & Co., Dallas, Texas.

Randall, W. C., de Laureal & Moses, New Orleans, La.

NEW YORK SECTION

Associate Members:

Cohen, W. A., E. B. Latham & Co., New York, N. Y.

Ganzenmuller, George, McGraw-Hill Publishing Co., New York, N. Y.

Hooper, A. W., McGraw-Hill Publishing Co., New York, N. Y.

Johnson, E. B., Westinghouse Electric Corp., Newark, N. J.

Keck, J. N., Seelye, Stevenson, Valve, & Knecht, New York, N. Y.

Kennedy, G. J., Graybar Electric Co., Long Island City, N. Y.

Olbek, Gerard H., Graybar Electric Co., Inc., Long Island City, N. Y.

Pritchard, S. J., The Miller Co., New York, N. Y.

Rattner, S. D., 68 W. 238th St., Bronx, N. Y.

NORTHERN CALIFORNIA SECTION

Associate Members:

DeSanto, J., Incandescent Supply Co., San Francisco, Calif.

MacNabb, J. A., Underwriters' Laboratories Inc., San Francisco, Calif.

Taylor, Arthur, Peerlite Mfg. & Supply Co., San Francisco, Calif.

OHIO VALLEY SECTION

Associate Member:

Schwalbach, E. P., F. D. Lawrence Electric Co., Cincinnati, Ohio.

OREGON SECTION

Associate Members:

Hoag, R. H., Portland General Electric Co., Portland, Ore.

Kingsley, D. G., Luxor Lighting Products Corp., New York, N. Y.

PITTSBURGH SECTION

Member:

Leberknight, C. E., Kopp Glass, Inc., Swissvale, Pittsburgh, Pa.

Associate Members:

Bright, J. E., Kopp Glass Co. Inc., Swissvale, Pittsburgh, Pa.

Slater, Phil., Sylvania Electric Products Inc., Pittsburgh, Pa.

Thomas, D. C., Sylvania Electric Products Inc., Pittsburgh, Pa.

PUGET SOUND SECTION

Member:

Adam, R. E., North Coast Electric Co., Seattle, Wash.

Associate Members:

DeHart, J. H., Mallis & DeHart, Seattle, Wash.

Linert, E. J., North Coast Electric Co., Seattle, Wash.

Meyer, A. L., Boullion & Griffith, Seattle, Wash.

O'Connor, K. T., Puget Sound Power & Light Co., Mt. Vernon, Wash.

ROCHESTER SECTION

Member:

Kridel, N. T., Rochester Gas & Electric Corp., Rochester, N. Y.

Associate Members:

Cornelius, W. G., Westinghouse Electric Supply Co., Rochester, N. Y.

Pritchard, E. L., 144 Commonwealth Rd., Rochester, N. Y.

ST. LOUIS SECTION

Associate Members:

Baer, A. W., Sverdrup & Parcel Inc., St. Louis, Mo.

Breckenkamp, H. A., Princeton Mfg. Co., St. Louis, Mo.

Carl, J. C., Carl Electric Co., E. St. Louis, Ill.

Fleischer, O. E., City Sales, St. Louis, Mo.

Huntsman, J. F., Osborn Electric Co., St. Louis, Mo.

Krick, R. M., Jr., Sylvania Electric Products Inc., St. Louis, Mo.

Mayer, J. A., Joseph A. Mayer & Co., St. Louis, Mo.

PLANNING LIGHTING FOR INDUSTRY? . . .

New American Standard explains industrial lighting in all of its aspects. Gives details on specific jobs and industries. Contains all you need to know about industrial lighting levels and quality; luminaire types; inspection and supplementary lighting; maintenance practice and other items; fully clarified and indexed, tables, charts and graphs. Completely illustrated, 40 pages.

Especially useful to lighting and consulting engineers; architects; plant maintenance and management people; construction engineers.

NEW

American Standard Practice for Industrial Lighting

40 pages

50 cents per copy; quantity prices on request

(Use Coupon on page 33A, Item 10)

Order from

PUBLICATIONS OFFICE

ILLUMINATING ENGINEERING SOCIETY

1860 Broadway New York 23, N. Y.

AMERICA'S FINEST FLUORESCENT LIGHTING for every requirement

Send for complete Smithcraft catalog

● Smithcraft AREA ILLUMINATION

● Smithcraft ARCHITECTURAL TROFFERS

● Smithcraft COMMERCIAL FIXTURES

● Smithcraft INDUSTRIAL FIXTURES

Smithcraft LIGHTING DIVISION CHELSEA 50, MASS.

A Word About I. E. S. Publications

To Lighting Executives of . . .

Power Companies and Manufacturers of Lighting Equipment

Are you making greatest use of I.E.S. facilities? Or can your organization profit more from Society developments? Do you know all of the working tools available from I.E.S.?

Each year since 1906 committees and individual members of the Society from every walk of the lighting field have been responsible for new developments in the "art and science of illumination." These committees and individuals have assembled a library of lighting knowledge recognized as the most authoritative, comprehensive and complete in the field.

Every morsel of this information has been published in some form or another by the Society and all of these I.E.S. publications are available either singly or in quantities at a minimum price consistent with sound business costs. They can serve you and the cause of good lighting best by the widest possible distribution.

Does your organization make the most use of I.E.S. publications? Many power companies and manufacturers do, not only within their staffs but by distribution of I.E.S. lighting publications . . . to customers or prospective customers in their service areas; to architects; consulting engineers . . . promoting good lighting of every description . . . effectively, authoritatively, inexpensively.

Check over the list of I.E.S. publications. If there is not a publication listed to meet your immediate or foreseeable needs, we still may have one. Write for further information and inexpensive quantity prices.

PUBLICATIONS OFFICE

ILLUMINATING ENGINEERING SOCIETY

1860 BROADWAY NEW YORK 23, N. Y.

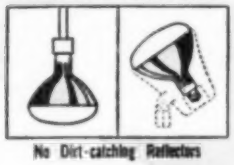
RADIANT HI-FLOOD

Reflector Weatherproof **FLOODLAMPS**

NICKEL PLATED BASE
WEATHERPROOF HARD GLASS
SILVER REFLECTOR INSIDE STAYS BRIGHT ALWAYS
MAXIMUM LIGHT OUTPUT · WIDE BEAM

Cost Less to INSTALL to MAINTAIN

INDOORS or OUTDOORS



No Dirt-catching Reflectors

200 to 1000 Watts
Std. or High Voltage

Radiant Hi-Flood Floodlamps reduce industrial lighting costs many ways. They cost less to install, indoors or outdoors by eliminating need of heavy, expensive fixtures. High light output maintained throughout lamp life. Saves power. No fixtures to polish. Sealed-in silver reflector.

Radiant Technical Bulletin 80 gives full details. Send for it.

RADIANT LAMP CORPORATION, 300 Jelliff Avenue, Newark 8, N. J.

Manufacturers of Lamps for PROJECTION ● FLOODLIGHT ● SPOTLIGHT ● MOTION PICTURE PRODUCTION SOUND REPRODUCTION ● AERONAUTICAL ● SPORTS LIGHTING AND GENERAL SERVICE ● RECTIFIER BULBS

Osborn, Everett, Osborn Electric Co., St. Louis, Mo.

SAN JACINTO SECTION

Associate Members:

Booth, T. C., Crouse Hinds Co., Houston, Texas.

Dill, J. F., Sylvania Electric Products Inc., Dallas, Texas.

SOUTHERN CALIFORNIA SECTION

Members:

Vlahos, Petro, Motion Picture Research Council, Inc., Los Angeles, Calif.

Meares, W. A., M-Lighting Testing Laboratory, Sherman Oaks, Calif.

Associate Members:

Berrigan, R. V., Local Union 1710, International Brotherhood of Electrical Workers, Los Angeles, Calif.

Blakely, C. A., Jr., Smoot Holman, Inglewood, Calif.

Freund, Karl, Photo Research Corp., Burbank, Calif.

Haist, C. P., Albert C. Martin & Associates, Los Angeles, Calif.

Kelley, L. E., Corning Glass Works, Venice, Calif.

Lacy, C. S., Industrial Electronics Corp., Los Angeles, Calif.

Perkins, L. J., General Electric Supply Co., Los Angeles, Calif.

Platt, J. G., Holophane Co. Inc., Los Angeles, Calif.

Renke, J. W., City of Redondo City Hall, Redondo Beach, Calif.

Ryer, L. M., Hilburg & Hengstler, Los Angeles, Calif.

Skatt, H. M., Incandescent Supply Co., Los Angeles, Calif.

SOUTHWESTERN SECTION

Associate Members:

Donahue, F. J., Leader Electric Co., Lubbock, Texas.

Morton, T. L., General Electric Co., Lubbock, Texas.

Sartin, Miss Jean L., Electrical Supply Corp., Dallas, Texas.

TORONTO SECTION

Members:

Barker, F. E., Northern Electric Co., Ltd., Toronto, Ont.

Pollock, H. S., Queen's University, Kingston, Ont.

TWIN CITY SECTION

Associate Members:

Hagstrom, D. S., Lang Engineering Co., Minneapolis, Minn.

Lange, A. W., 2513 Virginia Ave., St. Louis Park, Minn.

UTAH CHAPTER

Associate Members:

Hoggard, J. M., Utah Power & Light, Salt Lake City, Utah.

Mulcock, W. F., Utah Power & Light Co., Salt Lake City, Utah.

Nelson, A. L., Graybar Electric Co., Inc., Salt Lake City, Utah.

WESTERN MICHIGAN CHAPTER

Associate Member:

Miller, J. Q., Consumers Power Co., Muskegon, Mich.

WINNIPEG CHAPTER

Associate Member:

Woods, G. H., Northern Electric Co. Ltd., Calgary, Alta.

WANTED

MANUFACTURER'S REPRESENTATIVES FOR ELECTRICAL POWER AND LIGHT TRANSFORMER LINE

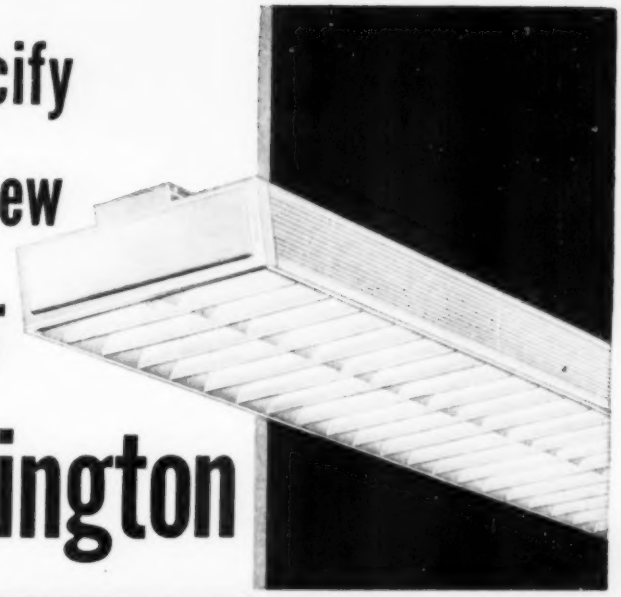
Recently expanded production facilities enable us to accept applications for several choice territories. Exclusive assignment will be made to qualified representatives thoroughly acquainted in the electrical jobber and contractor field.

We are a fast growing, well established organization, manufacturing a complete, competitively priced line of light and power transformers. From 3 to 150KVA. Prompt deliveries, lucrative commissions and full factory cooperation is assured. Inquiries invited from aggressive sales organizations handling related lines. Give full details in first letter. All replies confidential. Address Box 183, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

INDEX TO ADVERTISERS
February 1953

Advance Transformer Co.	11A
Benjamin Electric Mfg. Co.	17A
Champion Lamp Works	38A
Corning Glass Works	35A
Curtis Lighting Inc.	4A
Day-Brite Lighting Inc.	36A
Garden City Plating & Mfg. Co.	24A
General Electric Co., Apparatus	14A-15A
General Electric Co., Lamp	23A
Edwin F. Guth Co.	Back Cover
Jefferson Electric Co.	27A
Kopp Glass Inc.	31A
Leader Electric Co.	12A
Litecontrol Corp.	33A
Miller Co.	41A
Mitchell Manufacturing Co.	21A
R.L.M. Standards Institute	Inside Back Cover
Radiant Lamp Corp.	40A
Rohm & Haas Co.	28A
Smithcraft Lighting Division	39A, 42A
Sola Electric Co.	34A
Sunbeam Lighting Co.	42A
Superior Electric Co.	18A
Sylvania Electric Products Inc.	30A
Unistrut Products Co.	37A
F. W. Wakefield Brass Co.	Inside Front Cover
Westinghouse Electric Corp., Lighting	1A

specify the new miller Burlington



for correct store lighting

CORRECT LIGHTING is an important factor in the making of sales—it puts customers at their ease—enables them to see merchandise at its best—speeds IMPULSE buying.

The new Miller BURLINGTON—a distinct advance in store lighting—provides CORRECT lighting of high efficiency without glare. It provides it at L. O. C. (low overall cost)—through engineering features that make for easier, quicker installation, and materially reduce cost of maintenance.

Write for Burlington Folder

Miller has a complete line of Fluorescent, Mercury and Incandescent luminaires, covering a wide range of industrial and commercial lighting requirements. NATION-WIDE SERVICE is available through Miller field engineers and distributors.

High lighting efficiency—no glare
Extremely strong, rigid one-piece steel louver assembly
Engineered for easy lamping and servicing
Modern design—architecturally styled for interior harmony

THE miller COMPANY
SINCE 1844
meriden, conn.

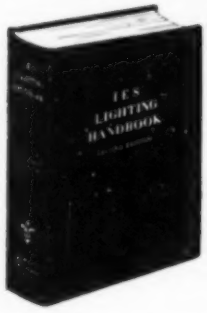
AMERICA'S FINEST FLUORESCENT LIGHTING for every requirement

Send for complete Smithcraft catalog

Smithcraft AREA ILLUMINATION
Smithcraft ARCHITECTURAL TROFFERS
Smithcraft COMMERCIAL FIXTURES
Smithcraft INDUSTRIAL FIXTURES

Smithcraft LIGHTING DIVISION
CHELSEA 50, MASS.

Is YOURS The Latest?...



You can't be sure you have *all the facts* about lighting unless you have a copy of the new . . .

Second Edition

I.E.S. LIGHTING HANDBOOK 1952

Prepared by I.E.S. technical committees, this 987-page lighting compendium contains 18 sections of lighting practice, theory and calculations . . . Appendices . . . Manufacturers' Reference Data . . . 655 photos, drawings, lighting tables, charts, graphs, to help you solve tough lighting problems.

If your problems are lighting problems, don't be another day without the new I.E.S. LIGHTING HANDBOOK.

Price . . . $8.00

I.E.S. Members: If you have not ordered, your special member copy is only $5.50 now.

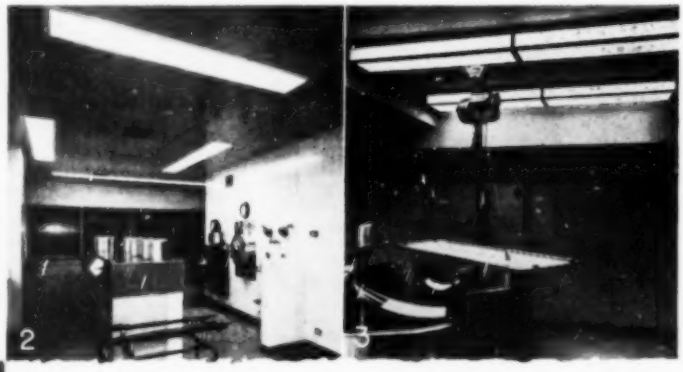
ORDER NOW!

Publications Office

ILLUMINATING ENGINEERING SOCIETY
1860 BROADWAY NEW YORK 23, N. Y.

WHEN LIFE DEPENDS UPON LIGHT . . .

Specify Sunbeam Lighting



Hospitals, more than any other institution, require dependable performance from all of its equipment at all times. Since proper illumination plays a major part in the optimum function of such an installation, it is no wonder that architects and contractors look to Sunbeam Lighting. Typical of many Sunbeam installations is the new Maternity and Pediatrics wing of the Cedars of Lebanon Hospital, Los Angeles (views 1 and 2). Nearly 600 #HLB5600-96, low brightness units were used for general lighting throughout the laboratories, surgical rooms, corridors, and other work areas. Note view #1 how peripheral lighting was used to good advantage in reducing contrasts. View #3 shows Sunbeam's fully enclosed HCA1714-96 units in one of the physical therapy rooms of the Milwaukee Hospital Annex, Milwaukee, Wisconsin.

SUNBEAM LIGHTING COMPANY
777 EAST 14TH PLACE LOS ANGELES 21, CALIFORNIA

FREE booklet

answers 17 most frequently-asked questions about this label on industrial lighting units, such as:

Q What do the initials RLM stand for?

A The "R" stands for Reflector, the "L" for Lighting equipment and the "M" for Manufacturers—*Reflector* and *Lighting Equipment Manufacturers.*

Q How does the RLM Label assure conformance to RLM Standards?

A Representatives of the Electrical Testing Laboratories periodically visit the plants of all manufacturers participating in the RLM Specification-Certification Program. These ETL inspectors are authorized to take lighting units right off the assembly line or out of stock at random and make the required tests. They may also obtain test samples direct from distributors' stocks in order to check conformance to RLM minimum standards.

Q Who are the Electrical Testing Laboratories?

A Electrical Testing Laboratories, Inc., 2 East End Ave., New York 21, N. Y., is an independent testing organization which has conspicuously served industry for over 50 years. With this impartial and scientific organization rests the sole responsibility of determining whether or not an industrial lighting unit measures up to every individual quality standard that qualifies it to bear the RLM Label.

Q What are the 4 Basic Tests made by Electrical Testing Laboratories?

A (1) Quality of reflecting surface, (2) Reflection factor, (3) Shielding angle and reflector dimensions, and (4) Photometric test for light distribution and efficiency.

Q What does the RLM Label stand for?

A The label affixed to a lighting unit certifies that the reflector meets the minimum specification and performance standards, determined and established by the RLM Standards Institute.

Q Who sponsors the RLM Standards Institute?

A Incorporated as a non-profit organization, the Institute is sponsored by 28 manufacturers who voluntarily elect to manufacture industrial lighting equipment in accordance with RLM Standard Specifications.

Q How are RLM Standard Specifications established?

A The RLM Technical Committee, with the counsel of outstanding illuminating engineers, continuously reviews present specifications and suggests improvements and prepares new specifications. The Committee's recommendations then are reviewed by the Board of Trustees and finally submitted to the Institute Members for ratification. The adoption of new specifications requires approval by at least 80% of the membership.

Q In addition to design and construction features that meet certain minimum standards, what else does the RLM Label assure the buyer?

A It provides the buyer with a warranty of uniform quality. In addition to the periodical inspections and tests made by the Electrical Testing Laboratories, the manufacturer warrants that every unit shipped by him meets the published specifications of the Institute.

Q How many different types and sizes of RLM Units are there?

A There are 18 basic types of RLM Units made by one or more of the 28 member-manufacturers. At present there is available a total of over 320 different makes and types of units which either bear the RLM Label or are on submittal for testing and certification at Electrical Testing Laboratories.

Q How may I obtain free copies of all existing RLM Specifications and a check list of RLM-Member Manufacturers?

A Send for the 48-page RLM Specifications Book and the new Question and Answer booklet. Write RLM Standards Institute, Suite 823, 326 W. Madison St., Chicago 6, Ill. Your copies will be mailed without cost or obligation.

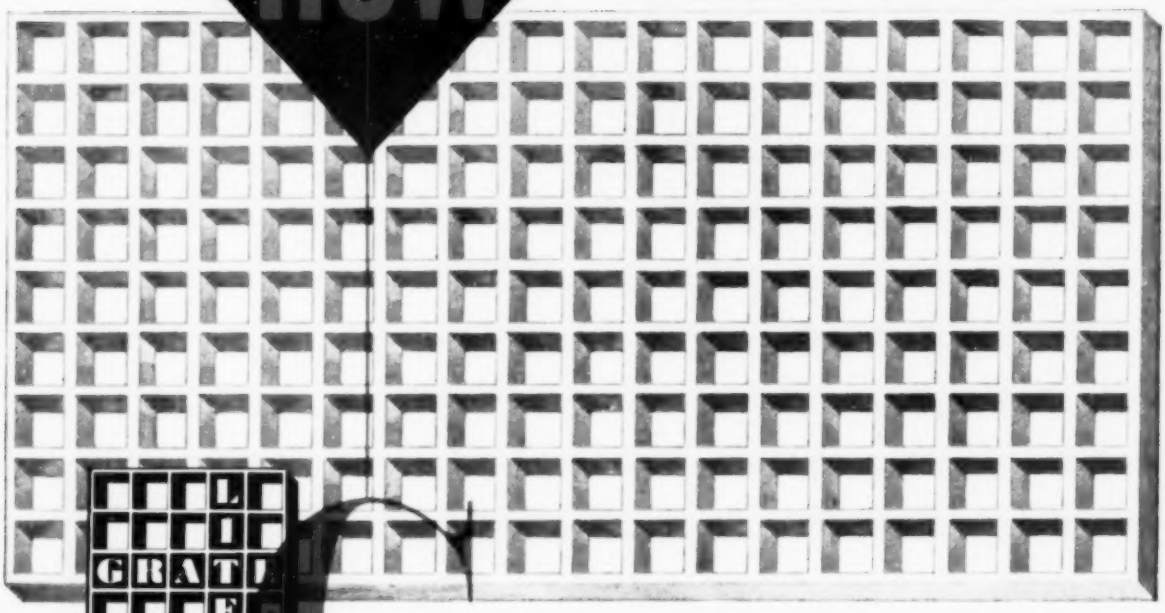
RLM STANDARDS INSTITUTE

The letters RLM stand for Reflector and Lighting Equipment Manufacturers

R51ORR

new

OPEN LIKE A LATTICE
DIFFUSING LIKE GLASS



Guth GrateLite* Louver

the latest idea in lighting

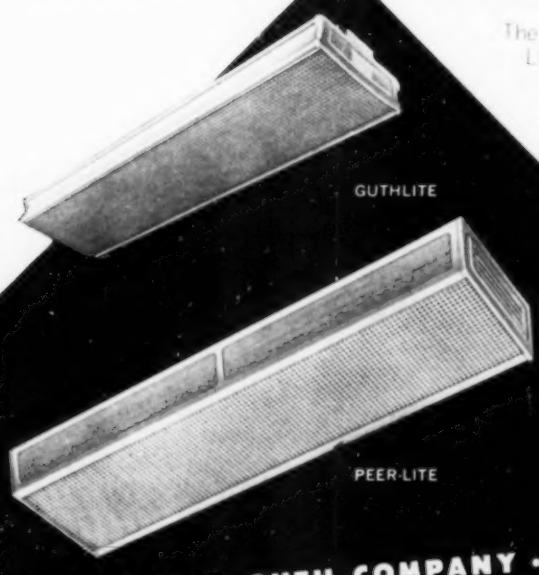
A SYMPHONY OF DIFFUSED LIGHT

The first integral plastic louver for fluorescent lighting, molded of LUSTREX polystyrene. It reveals a new conception of architectural beauty and efficient lighting. Its diffusion results from the ¾" cubical lattice that cuts off direct light at a 45° angle.

But words alone cannot describe beauty. See for yourself and ask to be shown a sample. It will give you a new outlook on lighting.

GrateLite is tough, quickly cleaned and destaticized. It is furnished in one piece with Guth Fluorescent Fixtures.

*U.S. & Can. Pats. Pend.



LEADERS IN LIGHTING

Guth

..... SINCE 1902

THE EDWIN F. GUTH COMPANY · ST. LOUIS 3, MO.